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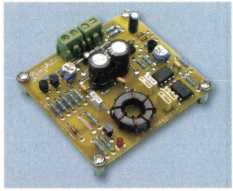

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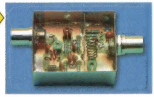

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# PUBLISHER'S LETTER

## Valve preamplifier a big hit

We were really surprised at the overwhelming response to the valve preamplifier featured in the November 2003 issue. It has generated more correspondence in just a month or so than any other project that we can remember. Not all of the response has been favourable, of course. Some people have said "Hiss, Boo" for featuring a circuit using ancient technology. That is partly the response we did expect and it is generally in line with our overall attitude to valves.

Generally though, the response was very favourable and not just because older readers regarded it as a trip down memory lane. Quite the contrary actually, because people realised that we had attempted to present a very realistic and detailed description of the technology and its capabilities. We did this because we had not seen a magazine article anywhere which explained the graphical method of gain calculations.

However, some of the responses were quite negative because we had used negative feedback to improve the performance and thereby negate the distortion characteristic of valves. Shock, horror! The circuit would now not be a musical or as "warm sounding" as "true" valve circuits really are. My response to that is "what a load of garbage!"

In hindsight, we should have published the distortion curves for the first circuit we produced, which did not have any feedback. Its distortion rose to over 6%.

Sure most of that would be low-order harmonics but anybody who thinks that level of distortion is OK or even desirable clearly doesn't understand sound reproduction. Why? Because any circuit producing high harmonic distortion ALWAYS produces high intermodulation distortion as well. And while low-order harmonic distortion might be regarded as innocuous or even preferable, intermodulation (production of sum and difference frequencies between two or more input frequencies) is always unpleasant. In fact, intermodulation over a couple of percent is just horrible.

It is also clear that some musicians think that valve amplifiers have benign "soft overload" or "soft" clipping, as opposed to the "undesirable" hard clipping typical of solid-state amplifiers with lots of negative feedback. Well, that ain't the case either, as the scope photos on page 6 of this issue clearly demonstrate.

Most push-pull valve amplifiers do use modest feedback but once they go into clipping, the weaknesses in the output transformer generally conspire to produce truly horrible distortion as you drive them seriously into overload.

We took these measurements a year or so back on a commercial valve guitar amplifier. It was quite instructive for me, as I had forgotten just how bad valve amplifiers could sound! In fact, with a nominal power output of about 50 watts, its performance could be summarised in one word: gutless.

Will we publish another valve audio circuit? Possibly. A new valve power amplifier? Maybe. But if we do, you can be sure that we will pull every trick in the book to make sure that it is as "state of the art" as possible. It would be very quiet, have very low distortion and probably be very expensive. And if we couldn't make it very quiet and with low distortion, we would not publish it.

**Leo Simpson**

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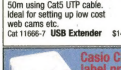

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Cat 11906
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Cat 11904

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Cat 11659-7 **4 way USB - KVM Switch** $449
Cat 11655-7 **4 way PS/2 - KVM Switch** $199
Cat 11657-7 **16 way PS/2-KVM Switch RKmount** $1,299
Cat 11654-7 **2 way PS/2 - KVM Switch** $119

Cat 11656

Cat 11658

Cat 11655

Cat 11657

Cat 11654

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Cat 3435-7 **NTSC PAL SECAM to PAL NTSC** $399
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Cat 3102

Cat 3436

Cat 3479

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Cat 11357

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Cat 11345

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# MAILBAG

### Support for valve preamp

Congratulations on the valve preamp project in the November 2003 issue! You have succinctly summed up the appeal of this project – for "people wanting to satisfy their curiosity about valve circuits".

The fact that valve amplifiers do not have the performance and cost advantages of solid-state does not mean that such projects have no value. If electronics is to flourish, the importance of projects that stimulate curiosity and provide educational value cannot be underestimated. The value of such projects is not measured in terms of technical performance.

One aspect of SILICON CHIP's success is the technical excellence of the projects. However, SILICON CHIP would not be harmed in the slightest if it continued to include the occasional project that is designed from a different perspective. This can only broaden the appeal of an already excellent magazine.

Sometimes, the most fun to be had in electronics is simply satisfying one's curiosity – the project doesn't have to be a world-beater! To draw an analogy, people (including young people) still take joyrides on steam trains and Tiger Moths – just to see what they're like. Judging by the smiles on the faces of these people, none seem disappointed with the fact that it's not the latest in transportation technology. Why should electronics be any different?

It would be great to see more of these types of projects. It would enrich rather than diminish SILICON CHIP and help to keep the interest in electronics alive!

**Name supplied but withheld at author's request.**

### Valve circuitry was better than claimed

I was quite happy to see the valve audio preamp design published in the November 2003 issue despite the fairly obvious reluctance to publish a valve project. However, I feel I must disagree with some of the comments made in regard to valve circuitry in both the article and editorial where the "traditional" non-use of negative feedback was mentioned more than once.

The benefits of negative feedback have been known for many, many years and it has been applied to valve audio equipment over many years. As an example, the EA-designed "Playmaster" valve audio amplifiers from the 1960s all used considerable negative feedback, improving the already basically good performance. In fact, those amplifiers, complete with the "ultra-linear" output stage, produced much better overall performance than the early "all transistor" amplifiers of the day, the latter often having quite serious problems with "crossover" distortion.

Admittedly, transistors were relatively new but the last generation of valve amplifiers were generally excellent. I am aware that valve preamps with excellent "specs" are still being made for true high-fidelity applications, here in Australia, along with consistent demand, and I am aware that very high quality microphones, complete with built-in valve preamps, are used in the recording industry around the world.

Valve circuitry is not perfect but in reality, it was much better than you've let on and it still has its dedicated followers.

**Felix Scerri, Ingham, Qld.**

*Comment: while negative feedback was commonly used in the better class of push-pull amplifiers, its use in small signal circuitry such as preamps, tone controls, etc was rare. Nor was the amount of negative feedback used in push-pull amplifiers very large, mainly because of phasing problems in output transformers. Anything more than 20dB of feedback would have been extremely rare.*

### Older DVD players won't play some new DVDs

I'm writing this in reply to a letter in the November issue regarding an issue of older DVD players being unable to read new DVDs.

I am an apprentice electronics technician working in Bendigo, Victoria. Just a few days after reading the letter about older DVD players being unable to read some new DVDs, I was confronted with such a unit on my bench. The fault description went something like this: "Plays older DVDs fine but not new ones".

I had it on my bench for a few hours testing different DVDs and it played without a hitch and just before I gave it back to the customer, I tried a few other DVDs which we don't normally test with.

With just one turn of the DVD the player decided it could not play the disc. It came up with a message "This type of disc cannot be played, please insert another disc". It wasn't that it had trouble reading it, it was just not supported by the player.

I tried another new disc I had on hand and the same thing occurred!

These two discs were the classic "The Great Escape" and "The Scarlet Pimpernel". Both discs were quite new and played fine on other newer DVD players. Region codes matched. It should have worked but it didn't. Anyway after this I thought of that letter in the recent issue of your magazine and it dawned on me that this was what I was encountering.

A quick phone call to the manufacturer concerned confirmed my suspicion. He told me that some older machines can't play some new discs due to the copyright method used on the disc and that there was nothing that could be done to the unit to make it play them.

By the way, this particular DVD player was part of a home theatre amplifier setup, so it would cost a fair bit

to replace with a new one! When you buy a DVD player, you would expect to be able to play any suitable region coded disc but apparently not.

**Erik Atkinson,**
**Bendigo, Vic.**

### Logging your driving nightmare

A comment on the "Logging Your Every Driving Moment" article on the November 1003 issue: why stop at logging just a subset of parameters for a short duration? Why not add a differential GPS receiver and the ability to receive database updates from roadside transmittters?

With what would be, in effect, a map of the local area (and speed limits) onboard the vehicle, the GPS position and velocity would make it possible to record speeding violations, perhaps based on time-of-day or day-of-week, on every single street, road and expressway in the country, 24 hours a day. A stylish LCD could even display the car's accumulated fines, payable at the next renewal of rego!

No poor radar/laser operators standing in the hot sun for hours at a time. No speed camera photos to develop and print. Cities would not have to maintain thousands of parking meters and ticket machines – the car would always know when and where it was parked, and for how long, and record this information to determine periodic payments as well.

I have no doubt that I could throw together a rough prototype of such a nightmare system for well under one thousand dollars. What could a team of professional designers accomplish? With the economies of scale – imagine such a device fitted to every single automobile and truck in the nation – and the potential revenue to be collected, governments would do well to pay for the development and manufacturing costs and give the devices to the auto makers for installation.

With a bit more sophistication and complexity it might be possible, at the driver's discretion, to have a mode where the vehicle simply would not exceed the speed limit on any given road at any time. The driver could then concentrate on looking out the windows and not at the speedo. Couple this with a decent navigation system and the "big brother" implications become (slightly) more palatable.

I'll bet I will live to see such a system or something very much like it.

**William H. Hanna,**
**Alice Springs, NT.**

*Comment: what fiendish ideas you have. Let's hope it never happens. Of course, some cars already use GPS in the Road Assist system and there is also the Road Angel system which logs all speed cameras and lets you know where they are.*

### Please explain one notion

The last sentence in the 12AX7 Valve Preamp project (November 2003) reads ". . . hear for yourself what 'valve sound' actually sounds like". However, the editorial in the same issue states that the amplifier probably would not have that valve "warm sound" due to the design implementing negative feedback.

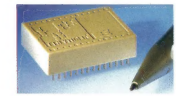
So what is the point of your design or what is the point of building the project in order to hear valve sound, if it does not deliver this? This project is an oxymoron. Or is it a biased political manoeuvre to dispel the appreciation of valves? Or are there two factions at SILICON CHIP with a conflicting stance concerning valve audio?

Perhaps the kit's charm will be iconic via the ginger glow of the heated vacuous space on top.

There is so much biased emotion in audiophile circles on the topic of valves. If valves do give a richer, truer sound as many state they do, is this for power amplifier stages that "cradle" the loudspeaker current, or is it at any stage like your preamp stage? Unless a sound system (a series system by its nature) is fully valve (including a 100% valve analog section CD player(!) playing 100% valve pickup, mixed and transcribed recordings!), obtaining true rich sound by merely adding on a valve preamp would logically imply the valve is merely adding a sonic character (distortion).

Hence, the "valve sound" is not a reflection of a truer reproduction but is an additive artifact (that could be emulated on a DSP with a "valve" setting). Or does the existence of your project imply that valves will give a truer richer reproduction


**The Tiger comes to Australia**



**The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.**

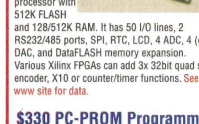
Tigers are modules running true compiled multitasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

**JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support.** See JED's www site for data.

**TIG505 Single Board Computer**

The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

**$330 PC-PROM Programmer**



This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

**Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.**

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over semiconductors for low level pickup amplification stages (guitar, microphones, phonogram cartridge) that silicon amplification will make sound "thin"?

To me, the only single notion that is agreed upon for valves is that (for active crossover systems) semiconductor power amplifiers are better for low bass frequencies due to better damping control of the subwoofer/woofer. (Use of valves in an active system would imply that valves are beneficial for power amplifier stages driving the loudspeaker driver, especially for the loosely defined "midrange" area.)

What is SILICON CHIP's philosophy? Do valves offer a truer reproduction (for what stage?) or do they just add a "rich, warm, pleasant" distortion? If SILICON CHIP does have a stance, would this be based on textbook engineering wisdom, on broad listening experience, or on double-blind listening tests?

Do you need time in the cooler to think this one out?

**Paul Rohde,**
**via email.**

*Comment: as you must have gathered, we have always been of the opinion that valve amplifiers were great in the past (when there was no other choice) but their day is long since gone. We regard any system having "warm sound" as clear evidence of distortion.*

## Beating Macrovision nuisance on an old TV

With DVD taking over in the video shops, we got a player. Our old TV has only an antenna input so the AV output from the DVD player has to pass through our VCR to be converted to RF. This is fine except that the Macrovision protection on the DVD makes it impossible to watch, as the picture fades, tears and pulsates.

So I built the SILICON CHIP "Dr Video" (April 2001) kit from Jaycar to stabilise the picture. It took an hour and 20 minutes to assemble, all the components were present and fitted perfectly and all the holes in the panels were in the right place. The stabiliser works perfectly. Thanks for a great circuit and a very professional and inexpensive kit. It is credit to SILICON CHIP and Jaycar.

**Chez Watts,**
**Brackenridge, Qld.**

## Argument about feedback

I bought the November 2003 issue with the valve preamp and would like to comment. For starters, your feedback from the plate of the second triode back to the cathode of the first is in fact positive feedback, though once its on the cathode the effect on the plate of the first triode is then negative. I know this is a small thing but an application of non-inverted signal is always positive feedback and an application of inverted signal is negative feedback – or am I wrong?

I have been a musician for many more years than I have been into electronics and one thing I've learnt is that, in the creation of music, as opposed to its reproduction, the controlled use of harmonic distortion is very, very useful and a significant part of sound shaping. For this reason it might be that your first version of the valve preamp, with the addition of a logarithmic pot instead of the grid resistor on the second stage, is actually of more use than the second version for the simple reason that the harmonic distortion is greater even if the amplification factor isn't so great.

I have a mixer using 5534 and TLO op amps and if I want valves, I would put them between the instrument and the mixer where amplification needs to be controlled. This is important and their use is mainly for an injection of harmonic distortion and a kind of DC bias shaping. Even if I were going straight to an amplifier I would still need these qualities more than pure gain. So I think you guys should be a little more mindful of the end uses of musical equipment and not be so concerned about what your own conditions of excellence are.

Also while the inverter power supply is nifty, it's basically a non-starter for musicians who usually have 9V effects and anyway it's a lot easier just to use two small transformers, with the second backwards, to build the power supplies for preamp duties.

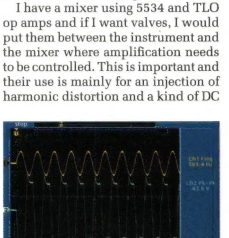
Please get the help of real musicians if more attempts are made at "musical" effects as up to now they have been mostly non-musical. In future, you will give your good selves much more credibility to "serious" musicians if you realise the vital importance of harmonic distortion.

**Sean Kerrigan,**
**via email.**

*Comment: the feedback is negative because it reduces the grid-cathode signal. The same thing occurs in any non-inverting direct coupled amplifier where the feedback signal is in phase with the input signal.*

*In our book, anything above 1% harmonic distortion is gross. Nor do we think that lots of second harmonic distortion is necessarily what musicians expect from valve amplifiers.*

*Many musos also think that valve amplifiers have "soft clipping". That isn't the case in a typical push-pull amplifier with feedback. The scope photos shown here demonstrate clipping in a commercial valve guitar amplifier. Its clipping is actually much worse and "harder" (ie, far more distortion) than in typical solid state amplifiers.* **SC**



**These two waveforms show severe overload occurring in a push-pull valve guitar amplifier on a tone burst signal. This is far worse than would occur in a typical solid-state amplifier.**

# Freeze Motion in the movies - how it's done

***Freeze motion is an effect which appears to have taken the motion picture world by storm. Here we take you behind the scenes to show how it is done and surprise, surprise – it is not done by computer generated effects.***

By BARRIE SMITH

If you've seen The Matrix films you'll know the effect: the action freezes and the camera tracks around the subject, usually with Keanu Reeves, skirts akimbo and eerily aloft, while dishing it out to the evil forces.

Or it may be a bullet, stopped dead, camera moving around it. If only levitation and suspension of the element of time were so easy!

When viewed on the big screen, the effect is rivetting. And these days when big budget films appear to be absolutely chockers with computer-generated imagery, it's refreshing to find this frozen-moment effect was perfected some 20 years ago by English visual artist Tim MacMillan and essentially uses well-proven photographic processes.

However, the principle of capturing an event in rapid, successive frames goes farther back to the days of Eadweard Muybridge, who shot his famous horse walking/trotting/cantering/galloping sequence (and many others) with an array of still cameras.

## Camera array

Which brings us to the term which best describes the principle item of hardware, the 'camera array'.

Put simply, the array is a firing line of still cameras, fixed to a sturdy metal bar or truss and curved in an arc around the subject. When the subject reaches a critical point in the frame, the cameras are fired either in unison or in very close succession (typically 10 milliseconds apart).

If fired simultaneously, the effect is christened 'frozen moment' or 'temps mort' ('dead time'); if in rapid succession, the name 'flow motion' is employed.

When the succession of frames is retrieved from the still cameras and collated together into a recognisable motion picture sequence, we get a 'movie'. The action is frozen (the shutter speed is often as fast as 1/1000 second or more) and sharp. But when the movie is run, the camera appears to be tracking around the subject.

An effective use of the effect is to edit it into a normal, 24 frame/second sequence shot; a motion picture camera is placed at either end of the still camera array and lined up to match the framing of the first or last of the multiple cameras.

So the frozen moment may follow a normal speed action, precede it or even be used in the middle of the 24 frame/second sequence.

Melbourne's Mark Ruff confesses to being "obsessed with this image technique" and has spent five years or more perfecting his own system. He is the first to clarify any confusion that he is connected in any way with the team that created the marvellous effects in The Matrix films; these were achieved with a film-based system, brought to Australia by Manex.

Film was also the basis of Marks' first array, which first fired its rapid shots in 1997.

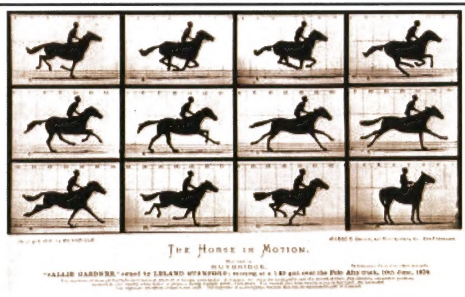
The inspiration came from seeing the BBC Natural History Unit series The Human Body, which employed Tim McMillan's Time Slice Camera:

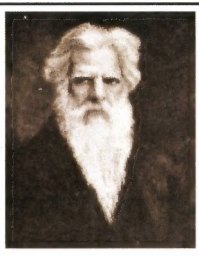
"I thought this guy is a hero for developing such a system. The Time Slice Camera holds one length of film within its casing and has a longitudinal array of lenses and shutters. Mark admits "this camera array has certain limitations", so MacMillan invited Mark to Scotland to shoot a job: "Rather than Tim spend a lot of time and money on an array, he got me [and the gear] over to do the job and he essentially directed the time slice component."

## Flare Obstacle

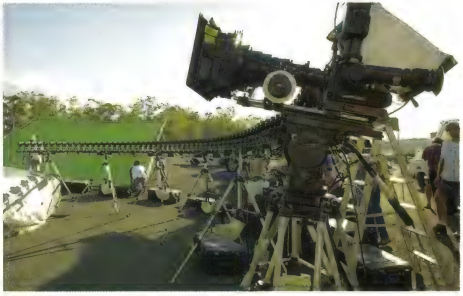
In common with some US systems, Mark Ruff's first approach employed 60 Pentax film SLR cameras and Sigma lenses. It worked. But there were many problems, mostly related to the build of the cameras and lens quality — flare was an obstacle — and even the shutter misfired on occasions when wear crept in.

Moreover, the system was unwieldy in the post process. Not only did a cassette of 35mm film have to be loaded



**The principles involved in "freeze frame" photography go right back to the days of the celebrated Eadweard Muybridge (shown above right) and his amazing (for the time) "Horse in Motion" series of photographs. These were taken in 1877 as a result of an earlier wager as to whether all four of a trotting horse's legs were ever off the ground at the same time. (He proved they were!) His work in stop-action series photography led to his invention of the "zoopraxiscope," a primitive motion-picture machine which recreated movement by displaying individual photographs in rapid succession.**



**In this shot a 35mm Arriflex 435 motion picture camera is placed at the start of the still camera array and lined up to match the framing of the first of the multiple cameras and 'hand over' the action (moving left to right on the screen) to it.**

into each camera pre-shoot, the exposed films then needed processing and scanning to become a digital image file. The frames then had to be recorded onto 35mm motion picture negative and a print made.

This took two days, before you could even screen the sequence! Making tests was often as costly as the final shoot.

## Digital to go!

As many amateur snap shooters have found, going digital will not necessarily save you money. Mark Ruff figures his move to digital cost him ten times that of a film approach but he describes the difference as "chalk and cheese". His current digital system is based on 30 Canon EOS 10D digital SLR cameras, complete with 30 Canon f3.5-4.5/24-85mm zoom lenses. If you walk into a camera shop, a single camera and lens will cost over $4000.

A digital rig, complete with 30 cameras, lenses and firing infrastructure can be set up ready to shoot within an hour. Doing a test is virtually free — aside from time. If a problem does arise, a re-shoot can be done immediately.

And as for post processing, the time from shoot to sequence preview-ready can be as short as 30 minutes. The client can then give an OK on the spot. At this point the digital to film transfer has yet to be made but these days film editing is computerised so the digital sequence can be cut into the main edit and the final recording to film done when all the other material is conformed.

At the moment, Mark's 'firing line' can only shoot frozen moment sequences. He feels that this type of action "can be handled in more ways than a non-linear, flow motion event. A non-linear "temps mort" effect can be ping-ponged and/or zoomed into repeatedly to increase screen duration. With flow-motion the action can only go in one direction. More cameras are simply needed for flow-motion.

A brace of 36 cameras is now available while 42 cameras is about the maximum the current infrastructure can handle, based mainly on the truss, which is nine metres long.

With a computer algorithm called 'sharp interpolation', partly developed by Tim MacMillan, it is possible to create inter-frames; a 36 camera system could then produce a 72-frame sequence or even more and deliver an on-screen 3-second sequence.

Normally, the cameras are spaced 20cm apart, lens centre to lens centre; this is governed by the space necessary at the camera's side to insert and remove the CompactFlash memory card. Initially, it took Mark about a week to get the system up and running, plus a further month to reach its current form. He admits the "previous four years of R&D helped of course — as I knew exactly what to do."

What also must have helped was a degree in physics, a Bachelor of Applied Science (Photography) from RMIT and nearly a decade of real experience as a technical director for Melbourne's Channel Ten. Mark has also owned a business/studio servicing commercial/advertising photography for almost ten years and been an ad agency staff photographer for three years.

He remembers RMIT taught him "how to 'think' about taking a photo rather than just teaching you 'how' to take a photo.

## From camera to the Mac

After a sequence is shot, all the CompactFlash cards are removed from the camera and images downloaded into a Macintosh G4 laptop: "An AppleScript sorts all the images into appropriate takes (taking about 30 seconds) and positional stabilisation achieved within minutes. Results can then be burnt to DVD as data and/or QuickTime files. It is therefore possible to shoot, do the necessary post and deliver to client all in the one day."

There are registration problems connected with so many shots taken by so many different cameras.

One disadvantage of a digital camera is that the CMOS image sensor does not consistently align with the camera's viewfinder screen: According to Mark, "It does not matter how accurate you are in an optical alignment, the pixels will never be in exactly that same spot you look at. It's around 20-40 pixels between each camera."

But this aside, he added, it is gratifying that all images are registered so, "once a stabilisation path has been executed for that camera set up, it applies for all takes. These framing,

## Time vs Speed

The frozen moment effect simulates a motion picture camera moving at great speed. However, in the real world, it is impossible to move a film camera at these speeds. The calculations are based on a rig which is on a 9 metre long truss. Shutter speed (time is frozen) at 1/1000 second. The 'window of time' is one millisecond. All cameras fire in this brief moment, so it is like travelling nine metres in one millisecond; 9km/second or 32,400 kilometres/hour.

**Bike Sequence:** In this series of shots taken with the techniqe described in this feature, you can see how much the background changes with respect to the bike rider who appears to be moving in slow motion. The sequence runs down the columns.

scaling, and rotational errors can be minimised (eliminated) with some clever software."

### Jobs done

So far, Mark's array has been used to capture frozen moment sequences in TV commercials for Toohey's, Eveready batteries, the Nine Network plus work for an Arnott's corporate video and various short films.

Mark is also a regular visitor to India's Bollywood, shooting TV commercials (one with cricketer Sachin Tendulkar in Mumbai) and an Indian-produced, Tasmanian-located feature, entitled 'Boys', which he describes as "a fantasy dream sequence ... three set ups a day in different locations for seven days."

He has also "collaborated with Dayton Taylor from Time Tracks who operates another version of a multiple lens camera. We worked on a BMW shoot in Hollywood together."

### What's Next?

Design is just about complete to do the following:

- Control all camera settings (ISO setting, colour temperature, shutter speed, lens aperture etc) from the one CPU. This is expected to be much quicker than a number of people manually adjusting cameras.
- Preview down-loading of the images could be achieved almost instantly upon exposure, by hooking into a PAL (or NTSC) video signal output from the camera. This means two things: on a shoot a client could see high-res results instantly. Near real time broadcast playback could also be made for various events, particularly sporting, as part of a super slow motion replay. This can be done within five seconds.

Mark has already conducted a test of a video replay using a motor car race as a trial. At the moment he is bullish about the rig and its capabilities.

He is confident "there are no limitations at the moment — other than the lack of an open cheque book to implement all the options possible. Even underwater is possible and an outer space project should seem easy without that gravity thing."

## The EOS 10D

While most digital SLR cameras have an image sensor that is half the area of the normal 35mm still film frame, by good fortune this is almost exactly the size of the motion picture frame. So data from a digital SLR has more than enough resolution for a movie, whether it be 4:3 or 16:9 or even 2.35 (CinemaScope) aspect ratio.

The EOS 10D has 3072 x 2048 pixels available in its 22.7 x 15.1mm CMOS sensor. The camera also has a PAL/NTSC video output, so tapping into this for a video preview is possible.

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Office at F.S.A. as well – contact Russell Cunningham 02 9360 5800
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# Studio 350 Pow
# Amplifier Modu

**Want an audio power amplifier with some real grunt? Want an audio power amplifier which is really quiet and has very low distortion? Here is the one answer for both desires. The Studio 350 is a rugged power amplifier module capable of delivering 200 RMS watts into an 8-ohm load and 350 watts RMS into a 4-ohm load, at very low distortion.**

**Pt.1: By LEO SIMPSON & PETER SMITH**

FOLLOWING THE outstanding success of our SC480 power amplifier module published in the January & February 2003 issues, we've taken the lessons learned there and from our Ultra-LD series published in 2000 and 2001 and applied them to a much bigger power amplifier.

There is no doubt the publication of the SC480 triggered off a lot of interest and since then we've had readers suggesting we update the 300W amplifier from the February 1980 issue of ETI. Others have asked about the possibility of upgrading the SC480 with bigger transistors and higher supply rails or variations on that theme. So the seeds were sown. A bigger amplifier was called for. But how much bigger? And using which transistors?

Looking at the SC480, for example, you can't increase the power output by simply substituting bigger output transistors and increasing the supply rails to some likely value. If you were to take that approach, other transistors in the circuit would blow up. And if you're driving low impedance (ie, 4-ohm) loads, the output transistors could easily expire as well.

Our first approach was to decide on the target power output, given a likely supply rail. Given that we have already published amplifiers capable of delivering 100 watts into 8-ohm loads (ie, the Ultra-LD series), the next likely step would be to aim for 200 watts into an 8-ohm load. A few back-of-an-envelope calculations show that we would need supply rails of about ±70V or a total of 140V.

Naturally, we would also want to drive 4-ohms loads and with those same supply rails we would expect to obtain around 350 watts. But how many output transistors and what type would be required? As you can see from the photos and circuit, we have used eight 250V 200W plastic power transistors: four MJL21193/4 complementary pairs. These are teamed with the high-performance MJL15030/31 complementary driver transistors (also used in the Ultra-LD series.

In addition, we have used some new high-voltage low-noise transistors in the input stage and highly linear high-voltage video transistors in the voltage amplifier stage. In other respects, the amplifier circuit is not much different from that of the SC480. Equally important, we have used the same PC board distortion-cancelling topology as in the SC480. The net result is a rugged power amplifier with very low residual noise and distortion.

## Load lines and power ratings

So why did we end up using eight 200W transistors in order to get just 200W into 8Ω and 350W into 4Ω? It might seem like over-kill but it is not. To work out the dissipation in a transistor, you need to draw the load lines. These show power dissipation in the

active device (in this case, one half of the output stage, consisting of four transistors). The vertical axis is in Amps while the horizontal axis is Volts. The various load lines for our amplifier are shown in Fig.1.

For a start, we plotted the lines for 8-ohm and 4-ohm resistive loads and these are straight lines, showing all possible conditions. The two resistive lines start at the 70V mark on the horizontal axis, corresponding to the supply voltage applied across one half of the output stage (either the NPN or the PNP transistors). For the 4Ω load, the load line runs up to 17.5A on the vertical axis, corresponding to the current delivered if the active device was fully turned on (ie, 70V ÷ 4).

Similarly, for an 8Ω load, the load line runs up to 8.75A on the vertical axis (ie, 70V ÷ 8). These load lines show the instantaneous power dissipation at any possible signal condition (including an output short circuit).

Also shown on the diagram are two hyperbolas. One represents the maximum safe power (for one second!) dissipation of four parallel-connected MJL21193/94 transistors. Depending on the instantaneous voltage across the transistors, this can be more than 900W for low voltages, reducing to 720W at 80V, and ultimately to just 400W at 250V (not shown on the curve). This hyperbola represents the maximum dissipation the four transistors can withstand under a non-repetitive one-second pulse, the so-called "Safe Operating Area".

Since the resistive load lines are well below the one-second SOA hyperbola, you may think that the transistors are operating far below their maximum ratings and so they would be, if all they had to drive was resistive loads. Sadly, loudspeakers are not resistive; they can be resistive, inductive or capacitive, depending on the signal frequency. Usually they are inductive which means the load current lags the load voltage.

This has two effects. First, the voltage across the output transistors can go much higher than the half-supply value of 70V. Conceivably, it can run to the full supply voltage of 140V (or beyond, if driven into clipping on an inductive load). Second, the instantaneous power dissipation across the power transistors can go far in excess of that shown for a resistive load line.

To show this effect, we have drawn 8Ω and 4Ω reactive load lines which represent speakers with complex impedances of 5.6Ω + j5.6Ω and 2.83Ω + j2.83Ω, respectively. In the 8Ω case, the 5.6Ω represents the voice coil re-

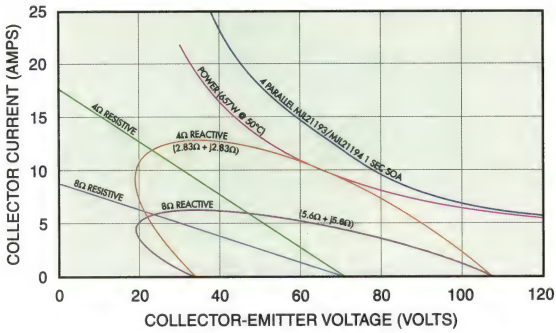



**Fig.1: this diagram shows the resistive and reactive load lines for both 4Ω and 8Ω loads. Also shown are two hyperbolas. The blue curve shows the maximum safe operating area of four parallel-connected MJL21193/MJL21194 transistors, while the red curve shows the derated power curve for 50°C case temperature.**

sistance while the j.5.6Ω is the coil inductance. The resulting curved load lines extend well beyond 70V (to almost 110V) and also show instantaneous dissipation figures far in excess of that for the resistive load lines. In fact, you can see that in the case of the 4Ω reactive case, there is far less power margin to spare.

In fact, we have also drawn the derated power hyperbola (50°C) for four transistors on Fig.1 and as you can see, it touches the 4Ω reactive curve. Does this mean there is a problem? Well no, because the load lines show instantaneous power dissipation, not average or total power dissipation. As long as the load lines are below the SOA curve, everything is OK.

All of the foregoing is a shortened explanation of the process whereby we decided to use eight transistors. It shows that eight is a good conservative figure whereas six of these transistors would not be enough.

Finally, before we leave the discussion on load lines, we need to mention short circuit and overload protection. Apart from fuses, this amplifier circuit has no protection. We could have chosen to run with six power transistors if we had incorporated "load line" protection into the circuit. This uses a pair of transistors to monitor the output transistor voltage and current conditions and then limit the base drive signal when the load line is exceeded.

Such circuits can work quite well to protect the output stage but in practice their rapid switching action causes a burst of high frequency oscillation to be superimposed on the output signal. This means that not only do you get horrible distortion but the amplitude of the burst can be enough to overload and burn out tweeters if the overdrive situation persists.

Therefore, while we regard load line protection as important for PA amplifiers (which can easily have their output leads shorted), it is not desirable for a hifi amplifier. If you do short the outputs of this amplifier when it is under full drive, there will be a big spark and hopefully the only thing to be damaged will be the 5A fuses.

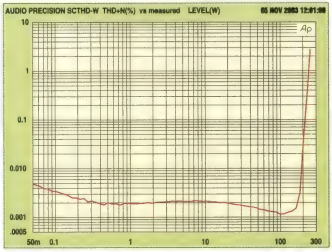



**Fig.2: total harmonic distortion versus power at 1kHz into an 8-ohm load (10Hz-22kHz measurement bandwidth).**

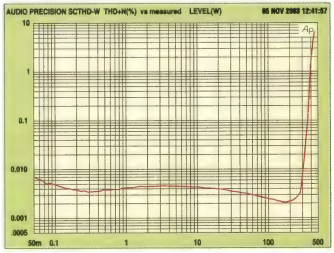



**Fig.3: total harmonic distortion versus power at 1kHz into a 4-ohm load (10Hz-22kHz measurement bandwidth).**

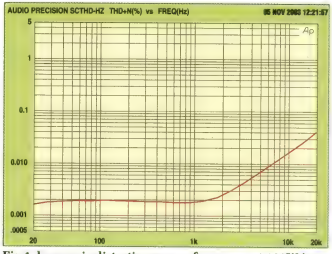



**Fig.4: harmonic distortion versus frequency at 160W into an 8-ohm load (22Hz-80kHz measurement bandwidth).**

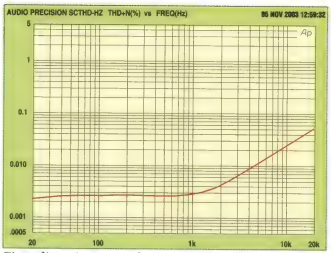



**Fig.5: distortion versus frequency at 250W into a 4-ohm load (22Hz-80kHz measurement bandwidth).**

If the fuses were increased in rating, the amplifier could ostensibly drive a 2Ω resistive load without damage, so we think the 5A fuses should provide adequate short circuit protection. Oh, but we don't recommend driving a 2Ω load!

By the way, we strongly recommend the use of a relay protection circuit to prevent loudspeaker damage in the event of a catastrophic fault in the amplifier. A suitable circuit was featured in the October 1997 issue of SILICON CHIP.

## Amplifier module

Two versions of this amplifier module are possible, both using the same PC board pattern. The one presented here employs a cast aluminium heatsink with an integral shelf which is convenient for mounting the power transistors. This heatsink is 300mm wide and the PC board itself is 240 x 136mm so the overall assembly is quite large.

The alternative approach is to mount the output transistors vertically on a single-sided or fan heatsink, in which case the PC board would be trimmed to 240mm wide by 100mm deep. This latter approach takes up less chassis space. Both approaches will be described in the constructional details to be presented next month.

## Performance

As already noted, the Studio 350 delivers up to 200W RMS into an 8-ohm load and up to 350W into a 4-ohm load. Music power figures are substantially higher, around 240W into an 8-ohm load and 480W into a 4-ohm load. These figures apply only for the suggested power supply which we will come to later.

Fig.2 shows the total harmonic distortion versus power at 1kHz into an 8-ohm load while Fig.3 shows distortion versus power at 1kHz into a 4-ohm load. As you can see, for an 8-ohm load, distortion is around .002% or less up to about 180W, rising to around .03% or thereabouts at 200W. At low powers, below 0.5W, the distortion figure rises but that is due to residual noise, not distortion. In reality, at low powers the distortion is well below .001%.

Similarly, for a 4-ohm load, distortion is around .0045% or less for powers up to around 280W, rising to 0.1% at around 350W. These figures were taken with a measurement bandwidth of 22Hz to 22kHz.

Fig.4 shows harmonic distortion versus frequency at 160W into an 8-ohm load while Fig.5 shows distortion versus frequency at 250W into a 4-ohm load. Both these curves were taken with a measurement bandwidth of 22Hz to 80kHz.

All of these distortion curves show a performance which is outstanding. For 8-ohm loads, it is very close to that of the Ultra-LD amplifier published in November 2001, December 2001 and January 2002. As well, it is better than our Plastic Power amplifier of April 1996 and far better than our 500W amplifier described in August, September and October 1997. That's progress!

This amplifier is also extremely quiet: -122dB unweighted (22Hz to 22kHz) or -125dB A-weighted. This is far quieter than any CD player!

Fig.6 shows the frequency response at 1W into 8Ω. It is 1dB down at 15Hz and 60kHz.

## Circuit description

The full circuit is shown in Fig.7 and employs 15 transistors and five

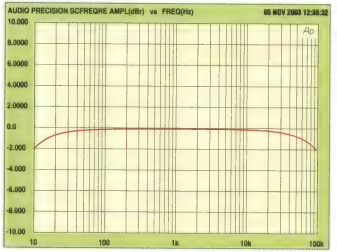
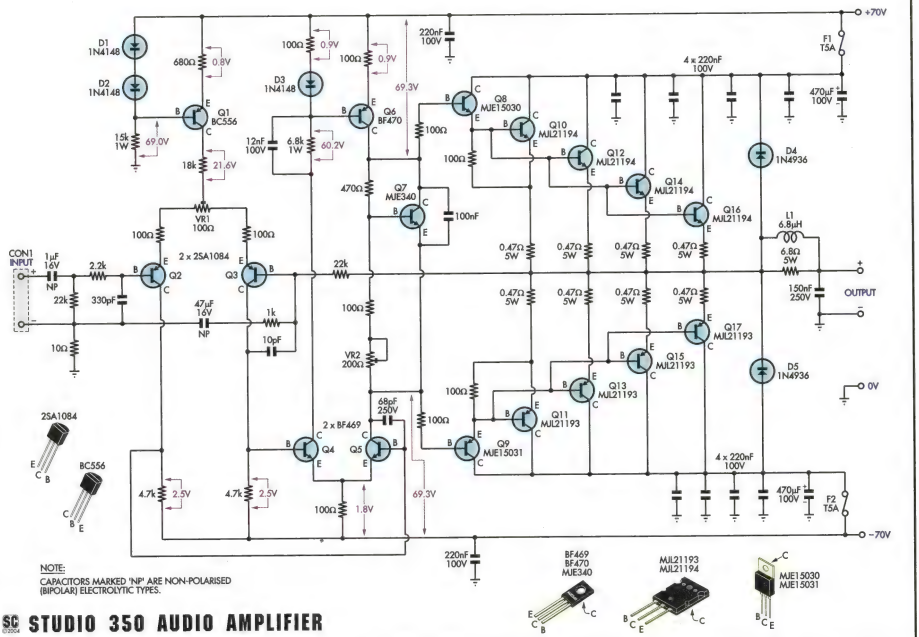



**Fig.6: this graph shows the frequency response at 1W into 8Ω. It is just 1dB down at 15Hz and 60kHz and is virtually flat between those frequencies.**




# STUDIO 350 AUDIO AMPLIFIER

**Fig.7: the circuit uses eight high-quality audio output transistors to give a rugged design with low distortion. The voltage readings on the circuit were taken with no input signal.**

## Performance

| | |
|---|---|
| Output Power | 200W into 8Ω; 350W into 4Ω |
| Music Power | 240W into 8Ω; 480W into 4Ω |
| Frequency Response | -1dB at 15Hz and 60kHz at 1W (see Fig.6) |
| Input Sensitivity | 1.75V for 200W into 8Ω |
| Harmonic Distortion | Typically .002% at normal listening levels (see graphs) |
| Signal-to-Noise Ratio | -122dB unweighted (22Hz to 22kHz); -125dB A-weighted, both with respect to 200W into 8Ω |
| Damping Factor | 75 at 10kHz, with respect to 8Ω |
| Protection | 5A supply fuses (see text) |
| Stability | Unconditional |

diodes. In essence, it is quite similar in layout to the SC480 design referred to earlier, which was based on a design originally produced by Hitachi.

The input signal is coupled via a 1µF bipolar capacitor and 2.2kΩ resistor to the base of Q2. Q2 & Q3 are a differential pair using Hitachi 2SA1084 low-noise transistors which have a collector-emitter voltage rating of 90V, necessary because we are using 70V rails. Transistor Q1 and diodes D1 & D2 make up a constant current source running at about 1mA to set the current through the differential pair at 0.5mA each.

Trimpot VR1 in the emitter circuit to the differential pair is provided to adjust the offset voltage and thereby trim the output DC voltage very close to 0V (within a millivolt or so). This is largely academic if you are driving normal 4-ohm or 8-ohm loudspeakers but is particularly desirable if you intend driving electrostatic speakers which usually have a high voltage step-up transformer with very low primary resistance.

The same comment applies if the amplifier is used to drive 100V line transformers. Just to explain that, if you have a transformer primary resistance of 0.1Ω and a DC output offset from the amplifier of just 20mV, the resulting current through the transformer will be 200mA! Not only will this magnetise the core and degrade the transformer's performance, it will also result in additional power dissipation of 14W in one half of the amplifier's output stage. This is not good! Hence, trimpot VR1 has been included.

Signals from Q2 & Q3 drive another differential pair, Q4 & Q5, which have a "current mirror" as their collector loads. The current mirror comprises diode D3 and Q6, essentially a variation of a constant current load which ensures high linearity in Q5. Q4, Q5 and Q6 are BF469 and BF470 types which are high-voltage (250V) video transistors, selected for their excellent linearity and wide bandwidth ($F_t$ is 60MHz).

Q7 is a "Vbe multiplier", so-called because it multiplies the voltage between its base emitter to provide a floating voltage reference to bias the output stage and set the quiescent current. Quiescent current is needed in all class-B amplifiers, to minimise crossover distortion. In fact, this amplifier displays no trace of crossover distortion.

We use an MJE340 transistor for Q7 even though a small signal transistor could easily handle the task. The reason for using a power transistor is that its package and junction does a better job of tracking the temperature dependent changes in the junctions of the output power transistors and thereby gives better overall quiescent current control.

The driver transistors are the high performance MJE15030 and MJE15031 made by On Semiconductor (previously Motorola). These were first used by us in the Ultra-LD series and have a minimum current gain-bandwidth product ($F_t$) of 30MHz. These drive the paralleled output stage MJL21193/94 transistors which themselves have a typical $F_t$ of around 6MHz.

Overall, this is a far superior line-up of transistors to that used in the SC480

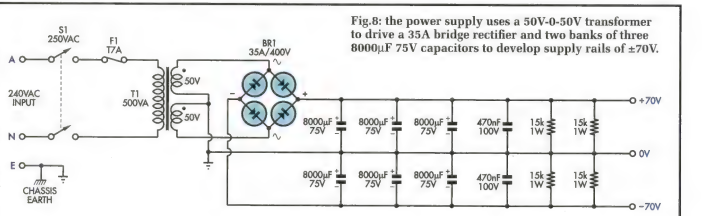
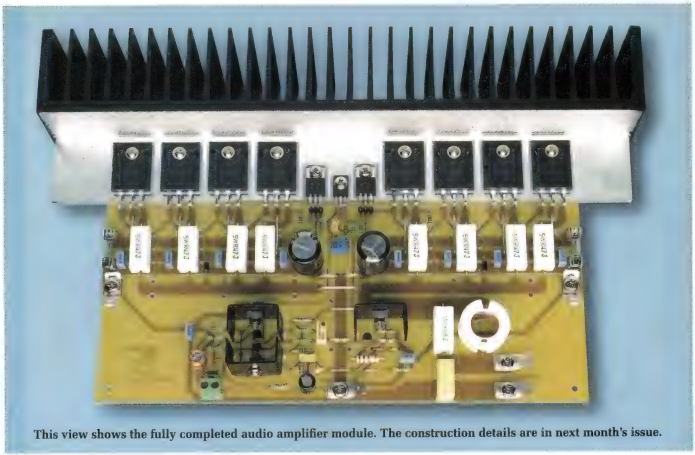



**Fig.8: the power supply uses a 50V-0-50V transformer to drive a 35A bridge rectifier and two banks of three 8000µF 75V capacitors to develop supply rails of ±70V.**

## SC STUDIO 350 POWER SUPPLY



**This view shows the fully completed audio amplifier module. The construction details are in next month's issue.**

amplifier (January & February 2003) and it results in far better distortion performance at high power and at higher frequencies.

Each of the power transistors in the output stage has 5W wirewound emitter resistor of 0.47Ω. This relatively high value has the disadvantage that it causes a slight reduction in power output but this has been done to provide improved current sharing between the output transistors – an important factor in a high-power design.

Although not shown in the photographs, one of our prototypes used non-inductive wirewound emitter resistors. These have been recommended in some past designs in overseas magazines, in order to minimise secondary crossover distortion effects. Our tests showed no benefit in this design (probably because of the PC board layout) and so they are not specified – ordinary wirewound emitter resistors are OK in this design.

Two 1N4936 fast recovery diodes are reverse-connected across the output stage transistors. Normally, these do nothing but if the amplifier is driven into clipping when driving highly inductive speakers or transformers, the diodes safely clamp the resulting back-EMF spikes to the supply rails.

## Negative feedback

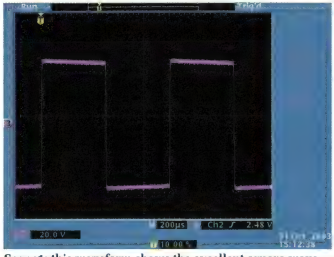
Overall negative feedback is applied from the output stage via the 22kΩ resistor to the base of Q3. The voltage gain is set by the ratio of the 22kΩ resistor to the 1kΩ resistor also connected to the base of Q3. This gives a voltage gain of 23 (+27dB). The 47µF bipolar capacitor in series with the 1kΩ resistor sets the -3dB point of the frequency response to about 3Hz. The other factor in the amplifier's low frequency response is the 1µF bipolar input capacitor.

We have used non-polarised capacitors for the input and feedback coupling instead of conventional electrolytic capacitors because the low voltages present in this part of the circuit are insufficient to polarise conventional electros. Incidentally, some readers may disagree with our choice of electros in the signal path but the alternative of plastic dielectric capacitors is not very attractive; they are large and expensive and unavailable, in the case of 47µF. Nor do we think that electrolytic capacitors, properly used, are the cause of high distortion in audio circuits; there's no evidence of it in the case of this circuit.

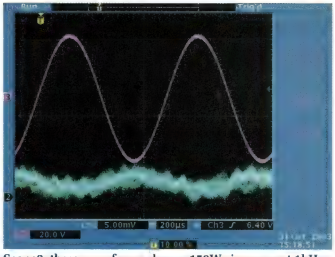
The 330pF shunt capacitor and 2.2kΩ resistor in series with the input signal constitute an RC low-pass filter, rolling off the high frequencies above 200kHz. The 68pF capacitor between Q5's base and emitter rolls off the open loop gain to ensure stability with feedback applied.

Note that this capacitor can be ceramic or polystyrene but must have a rating of 250V. This is because the signal at this part of the circuit can be as high as 45V RMS (127V peak-to-peak). Other capacitor types (such as monolithics) are definitely not recommended.

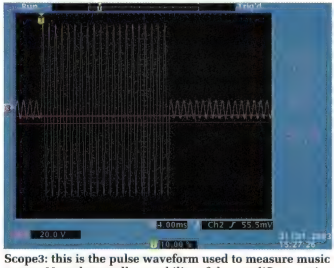
As in our previous amplifiers, the output signal to the loudspeaker is fed via an RLC filter consisting of 6.8µH choke, a 6.8Ω wirewound resistor and a 150nF capacitor. This very well-proven filter network was originally developed by Neville Thiele and published in the September 1975 issue of the "Proceedings of the IREE". The filter has two benefits: ensuring stability of the amplifier with reactive loads and as an attenuator of RF and



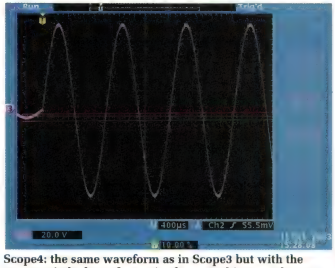

**Scope1: this waveform shows the excellent square wave response of the amplifier, taken at 1kHz and 102V p-p into 8Ω. This equates to a power output of about 300W RMS.**




**Scope2: these waveforms show a 150W sinewave at 1kHz and the resulting total harmonic distortion waveform (ie, noise and distortion) which is at about .0015%.**




**Scope3: this is the pulse waveform used to measure music power. Note the excellent stability of the amplifier, particularly the recovery after the pulse.**




**Scope4: the same waveform as in Scope3 but with the scope switched to a faster timebase. In this case, the amplifier is delivering over 240W RMS into an 8-ohm load.**

mains-interference signals which are inevitably picked up by long loudspeaker leads.

## Power supply

Fig.8 shows the power supply and as you can see, we've "gone for the doctor" on this one. It's a vital part of the performance package and unfortunately, with all those big electrolytic capacitors, is likely to be more expensive than the module itself. The consolation is that the same power supply could be used for a stereo version with two amplifier modules, provided the power transformer was uprated.

The 500VA transformer used has two 50V windings which are connected together to form a centre tap. This transformer drives a 35A bridge rectifier and two banks of three 8000µF 75V capacitors to develop ±70V supply rails. The 470nF capacitors are used to provide high frequency bypassing, while the 15kΩ 1W resistors are used as "bleeders" across the electrolytic capacitors.

## PC board topology

Finally, as noted at the start, the PC board has been laid out using the same distortion-cancelling topology used in the SC480. It also has "star" earthing whereby all earth currents come back to a single point on the board. This careful separation of output, supply and bypass currents avoids any interference with the signal currents and the distortion that this could cause.

As far as the "distortion cancelling" technique is concerned, this involves laying the copper tracks so that the magnetic fields produced by the asymmetric currents in the output stage are cancelled out, as far as possible. These asymmetric currents (think of them as half-wave rectified output signals) and their resultant magnetic fields induce unwanted distortion signals into the input stage involving Q2 & Q3.

Arguably, the field cancelling technique is not quite as successful in this design as in the SC480, because this new PC board is much larger and the output devices are more spread out. Even so, it is very worthwhile and constructors will not have to worry about whether the performance of their module is as good as the prototype featured here. As long as you closely follow the wiring layout in the construction article next month, you can expect the results to be very good. **SC**

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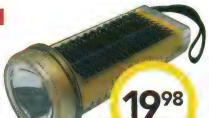

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# High-efficiency power supply

## For 1W Luxeon Star LEDs

**Looking for a highly-efficient switchmode power supply to run a 1W Luxeon Star LED from batteries? This easy-to-build design lets you use a pair of 1.5V "D" cells and includes brightness control to further extend the battery life.**

By PETER SMITH

LAST MONTH, we described a simple linear supply for driving Lumileds' 1W Luxeon Star LEDs. Designed with low cost and simplicity in mind, it is ideal for experimentation as well as general-purpose fixed lighting applications.

The downside to this simplicity is that it's not very energy efficient. However, for portable and emergency lighting applications, efficiency is of paramount importance. In a low-efficiency lighting setup, much of the available energy is consumed by the power supply itself, where it's dissipated as heat.

Conversely, an efficient supply transfers the majority of the input power to the output, thereby maximising battery life.

This high-efficiency switchmode design can drive a single 1W Luxeon Star for more than 20 hours (continuous use) from a pair of alkaline "D" cells. It also includes a brightness control which, when set to the lower end of the scale, will extend useful battery life many times over.

The PC board is the same size as two "D" cells side-by-side, making it ideal for use in lanterns, emergency lights, beacons, etc. We envisage it being used anywhere that a portable, reliable and ultra-long-life light source is required.

It can drive green, cyan, blue and royal blue as well as white 1W LED

## Main Features

- High efficiency (>85%)
- Brightness control
- 2 x 'D' cell powered
- 20+ hours continuous use
- Drives white, green & blue Stars

varieties, most of which are available locally from the Alternative Technology Association (see panel).

### Step-up DC-DC conversion

In common with our 2-cell LED torch design (SILICON CHIP, May 2001), the circuit is based around a MAX1676 step-up DC-DC converter IC. These devices were originally designed for use in mobile phones and the like.

Our circuit requires a step-up converter in order to boost the battery voltage, typically between 2.4V to 2.8V, to the higher 3.3V (nominal) required by the LED. Step-up conversion also assures maximum LED brightness over the lifetime of the batteries. To understand how this works, let's first look at a few of the basics.

### Boosting the battery voltage

The basic components of a step-up converter consist of an inductor, transistor (switch) and diode – see Fig.1. When the switch closes, the input voltage is applied across the inductor. The current flow (i) ramps up with time (t) and energy is stored in the inductor's magnetic field.

When the switch opens (Fig.2), an instantaneous voltage appears across the inductor due to the collapsing magnetic field. This voltage is of the same polarity as the input voltage, so the diode conducts, transferring energy to the output.

Fig.3 shows where these basic parts fit in our design. As you can see, most of the step-up circuitry is contained within the MAX1676. Q1 acts as the switch, with Q2 replacing the series diode. Q2 acts as a synchronous rectifier, eliminating forward voltage losses and therefore improving efficiency.

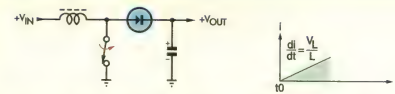



**Fig.1: when the switch closes, inductor current increases with time, storing energy in its magnetic field.**

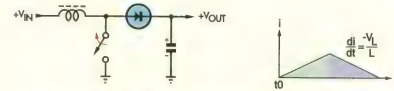



**Fig.2: when the switch opens, the magnetic field collapses. The inductor's energy is discharged into the capacitor and load via the diode.**

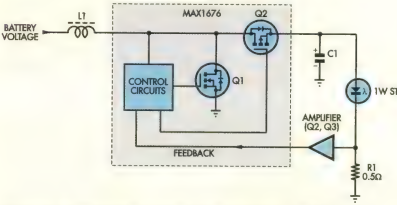



**Fig.3: this diagram shows the basic elements of the power supply. Most of the step-up circuitry is contained within the MAX1676 chip, including the switching transistor and rectifier.**

**Fig.4: On the bench, our prototype powered a Star for over 20 hours on "D" size alkaline cells. Even at 0.6V/cell, the supply was still pumping out more than half a watt (about 160mA). Almost full power is delivered to the LED down to 1.8V. This means that you'll get high brightness over the entire life of a set of rechargeables. Converter efficiency was measured at 90.1% with a 3.0V input, with a total circuit efficiency (input to output) of 85.5%.**

### Output control

The MAX1676 converter uses a current-limited pulse-frequency modulation (PFM) technique to maintain output regulation. Essentially, the switch is driven with a minimum pulse width, variable-frequency signal (up to 500kHz), which increases as battery voltage decreases. For a detailed description of its operation, check out the Maxim datasheet, available from **www.maxim-ic.com.**

When the battery voltage falls below about 1.8V, the output power decreases markedly due to the high input to output voltage differential (see Fig.4). For example, with only 0.5V per cell, a step-up ratio of about 3.3:1 would be required to achieve full power. Assuming about 75% ef-

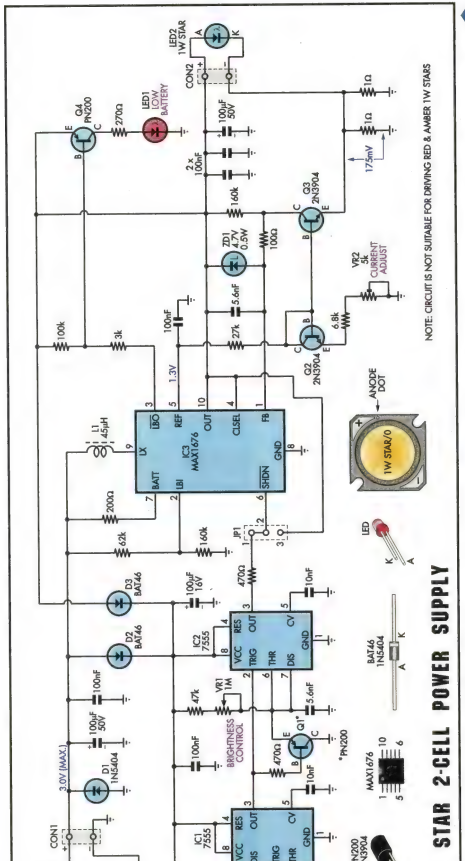



**Fig.5: the complete circuit diagram for the power supply. Two CMOS 7555 ICs modulate LED brightness by controlling the step-up converter's shutdown pin.**

ficiency, this means that the supply would have to pull around 1.4A from the (already) flat batteries. And with increasing cell resistance, this simply wouldn't be possible.

As you can see, reducing output power towards the end of battery life is actually desirable, as it allows the supply to almost drain a pair of alkaline cells. This reduces wastage and provides a useful amount of light for much longer.

Filament lamp circuits can't hope to match this result. To prove the point, try your torch batteries with this supply when they're almost knackered – you'll be amazed at the brightness of the LED compared to the incandescent bulb!

## Circuit description

The complete circuit diagram for the power supply appears in Fig.5. It consists of two main elements – the step-up converter (no surprises here) and two 7555 timers (IC1 & IC2). The timers are part of the brightness control circuit, which we'll come back to in a moment. First, let's complete the description of the step-up converter.

In a standard application, the MAX1676 (IC3) requires very little external circuitry to form a complete step-up power supply. However, in order to regulate output current (rather than output voltage) for our LED load, we've added a few components to the feedback loop.

Transistors Q2 & Q3 amplify the current sense voltage developed across the parallel 1Ω resistors. These two transistors are connected in a current mirror configuration, with Q2's base and collector connected to IC3's 1.3V reference output. Therefore, a known current flows through Q2. This is used to generate 175mV at the emitter of Q2 and by current mirror action, Q3 attempts to maintain the same voltage at its emitter.

The MAX1636's internal error amplifier compares the feedback voltage on pin 1 with a 1.3V reference. If it is less than 1.3V, the voltage at the output (pin 10) is increased, whereas if it is more, the voltage is decreased. This

has the effect of increasing or decreasing the current through the LED.

Q3's collector controls the voltage on the feedback pin, acting much like a common base amplifier. When its emitter voltage equals 175mV (for 350mA through the LED), the collector will be at 1.3V and the loop is in regulation.

Trimpot VR1 provides a means of adjusting the LED current to the desired 350mA, thus accommodating component tolerances. Zener diode ZD1 clamps the output to a maximum of 6V to protect IC3 should the LED fail or be inadvertently disconnected. The 5.6nF capacitor between the output and feedback pins ensures loop stability.

## Low-battery detection

Both rechargeable (NiCd/NiMH) and alkaline battery types can be used with the power supply. Alkaline batteries are a good choice for intermittent use, as they have a low self-discharge rate.

On the other hand, rechargeables work well for continuous use. Their lower internal resistance and relatively flat discharge curve provides a higher average level of light output over the discharge period compared to non-rechargeables.

Unlike non-rechargeables, it's important not to totally discharge NiCd and NiMH cells. Repeatedly doing so substantially reduces cell life. To help avoid this problem, the power supply includes low-battery indication.

When the voltage on the MAX1626's low-battery comparator input (pin 2) falls below an internal reference voltage (1.3V), the comparator's output (pin 3) goes low. This switches on transistor Q4, illuminating the "Low Battery" LED.

A simple voltage divider connected to the comparator input sets the trip point to about 1.8V (0.9V per cell). When running on alkalines, the LED provides a useful indication of battery condition.

## Brightness control

The brightness of a LED can be varied by varying the current through it. However, rather than varying the absolute level, Luxeon recommends pulse-width modulating (PWM) it instead. This results in a much more colour-uniform light output, right down to minimum brightness.

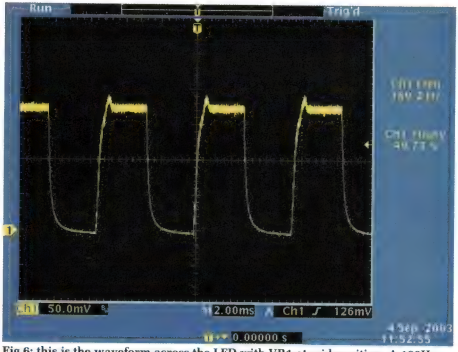



**Fig.6: this is the waveform across the LED with VR1 at mid-position. A 180Hz PWM frequency ensures that the LED appears to be always on. Note that the waveform is not a perfect square wave due to the time constant of the output filter capacitor.**

To realise PWM control, it's just a matter of switching the LED current on and off at a fixed frequency and varying the duty cycle (on/off time) to vary the brightness. By using a high enough frequency, the switching effects are invisible due to the long persistence of the phosphors (in white LEDs) and the natural integration of the eye.

On the power supply board, two 7555 CMOS timers (IC1 & IC2) form the core of the PWM circuitry. The first 7555 (IC1) is configured as a free-running oscillator. Its frequency of oscillation (about 180Hz) is set by the 680kΩ and 100Ω resistors and the 10nF capacitor on pins 2, 6 & 7.

The 100Ω resistor in the capacitor's discharge path is much smaller than the 680kΩ resistor in the charge path, resulting in a very narrow positive pulse from IC3's output. This is used to trigger the second 7555 (IC2).

IC2 is configured as a monostable, with the positive pulse width on the output (pin 3) made variable by 1MΩ trimpot VR1. Near the maximum pot setting, the positive pulse width is longer than the period of IC1. This is where transistor Q1 comes in – it is needed to discharge the 5.6nF timing capacitor, effectively retriggering IC2 and allowing a 100% duty cycle at the output.

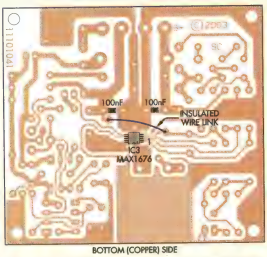
The fixed frequency, variable pulse width (PWM) output from IC2 is applied to the MAX1676's shutdown pin. When this pin goes low, the chip stops switching and goes into low-power mode. Fig.6 shows the waveform across the LED at VR1's mid position. As shown, this results in a 55% duty cycle or thereabouts.

Power for the 7555 timers and associated circuitry is provided via Schottky diodes D2 & D3. By sourcing power from the output as well as the input sides of the circuit, we ensure that the signal level applied to the MAX1676 shutdown pin tracks the output voltage and remains valid under all conditions.

Readers familiar with last month's Experimenter's Power Supply circuit may wonder why we've used a different (and more complicated) PWM circuit for this design. The answer is simple – this circuit must operate at much lower voltages (down to 1V), and therefore we cannot afford the diode losses in the timing network. Note also that we've used 7555 (CMOS) timers rather than 555 (NMOS) versions, which saves power and ensures low-voltage operation.

## Reverse battery protection

Most Silicon Chip designs include a diode in series with the DC input for protection against accidental




BOTTOM (COPPER) SIDE

**Fig.7: three SMD components go on the bottom side of the PC board and these must be mounted before anything else.**

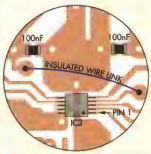



**Fig.8: a close-up section of the bottom side of the board, showing just the area of interest for the SMD components. Note how IC3's leads are positioned precisely in the centre of the rectangular pads.**

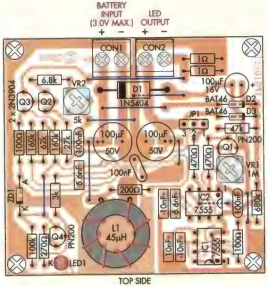



**Fig.9: follow this diagram when assembling the top side. Don't miss any of the links (there are 10 in all), and take care with the orientation of the ICs, diodes and electrolytic capacitors.**

supply reversal. However, a series diode in this circuit would seriously compromise efficiency and running time. Therefore, we've settled for a reverse diode (D1) across the input terminals.

A reversed supply will cause large current flow through D1 and, in the case of high-energy rechargeable cells, will quickly destroy it. In many cases, the diode will fail "short circuit", protecting the expensive (and hard to replace!) step-up converter IC.

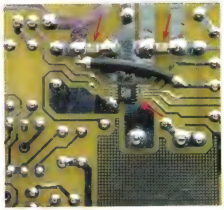
This is assuming, of course, that the batteries are only momentarily reversed. Leaving them connected for any length of time will cause heat damage to the board, or worse. If you're concerned about this possibility, then install a 2A quick-blow fuse in series with the positive battery lead.

## SMD soldering gear

Referring to the various photos and diagrams, you can see that the assembly includes three surface-mounted devices (SMDs) – the MAX1676 converter IC and two 100nF chip capacitors.

The MAX1676 is supplied in a tiny "uMAX10" package with 0.5mm lead spacing. Soldering this little device can be a challenge – even for experienced constructors. It must be mounted first, before any of the through-hole components.

The following items should be considered essential to the task:



**You will need fine (0.5mm) solder and a temperature-controlled iron to solder in the SMD components.**

- Temperature-controlled soldering iron.
- 0.8mm (or smaller) micro-chisel soldering iron tip.
- 0.76mm desoldering braid ("Soder-Wick" size #00).
- 0.5mm (or smaller) resin-cored solder.
- Needle-nose tweezers.
- Damp sponge for tip cleaning.
- Small stiff brush & alcohol/cleaning solvent.
- Magnifying glass and bright light for inspection.

In addition, the job is made easier with the aid of SMT rework flux, which is available in a 10cc syringe from Altronics (Cat. H-1650).

*Note: the ICs used in this project are static-sensitive. We recommend the use of a grounded anti-static wrist strap during board assembly.*

## Bottom side assembly

Begin by checking the PC board for defects. In particular, check for shorts between pads and tracks around IC3's mounting site. The magnifying glass and bright light will come in handy here. Use your multimeter to verify isolation between any suspect tracks.

Next, thoroughly clean the board with a lint-free tissue (or similar) moistened with alcohol or cleaning solvent. The rectangular IC pads must be pre-tinned and perfectly smooth (free of solder "lumps"). If you have SMT rework flux, apply a thin film to the mounting pads.

Using needle-nose tweezers, grasp the MAX1676 by its ends and inspect it closely under a magnifying glass. Make sure that the leads are all perfectly formed, with equal spacing and alignment in the horizontal plane. In

other words, they must all line up and make contact with their respective pads. Carefully adjust individual leads if necessary (you may need a second pair of tweezers).

Place the device in position on the board, with pin 1 aligned as shown in Figs.7 & 8 (double-check this!). Now, using your magnifying glass, make sure that the device is perfectly aligned over the rectangular pads. This is very fiddly and requires patience and a steady hand!

Next, clean your iron's tip and apply a small quantity of solder to it. With your third hand, apply light downward pressure on the MAX1676 to hold it in position. If the package moves (which it is liable to do), reposition it and start over.

Apply the tip to one of the IC's corner mounting pads, touching both the pad and IC lead simultaneously. The solder should "blob", tacking the chip in place. Check that the IC is still perfectly aligned over the rectangular pads. If it's not, carefully remove it and try again.

If you find that the package moves whenever you try to tack the first pin, then there is an alternative method. First, position the IC as described above and apply your iron to the track/pad just in front of the IC lead (don't touch the lead). Next, feed a little solder to the tip, and it should flow along the track/pad and up over the lead. This method is more successful when additional flux is used.

Now repeat the same procedure for the diagonal corner, effectively securing the IC in position. Check alignment again, as we're about to make this position permanent!

If you have SMT flux, apply it to all IC leads and the adjacent tinned copper areas. You can now solder the remaining eight leads. Apply heat to both the pad and lead simultaneously and feed a minimum amount of solder to the joint. Do not apply heat to any lead for more than two seconds!

Despite your best efforts, you're certain to get "blobs" of solder and perhaps even solder bridges between adjacent pins. Don't despair – this can be fixed!

This view shows the fully assembled PC board. Take care to ensure all parts are installed correctly.

Again, if you have SMT flux, apply a minimum amount to all IC leads and adjacent PC board copper. Next, position a length of fine desoldering braid across the ICs leads and heat with a freshly tinned iron.

## Table 2: Capacitor Codes

| Value | µF Code | EIA Code | IEC Code |
|---|---|---|---|
| 100nF | 0.1µF | 104 | 100n |
| 10nF | .01µF | 103 | 10n |
| 5.6nF | .0056µF | 562 | 5n6 |

## Table 1: Resistor Colour Codes

| ❑ | No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|---|
| ❑ | 1 | 680kΩ | blue grey yellow brown | blue grey black orange brown |
| ❑ | 2 | 160kΩ | brown blue yellow brown | brown blue black orange brown |
| ❑ | 1 | 100kΩ | brown black yellow brown | brown black black orange brown |
| ❑ | 1 | 62kΩ | blue red orange brown | blue red black red brown |
| ❑ | 1 | 47kΩ | yellow violet orange brown | yellow violet black red brown |
| ❑ | 1 | 27kΩ | red violet orange brown | red violet black red brown |
| ❑ | 1 | 6.8kΩ | blue grey red brown | blue grey black brown brown |
| ❑ | 1 | 3kΩ | orange black red brown | orange black black brown brown |
| ❑ | 2 | 470Ω | yellow violet brown brown | yellow violet black black brown |
| ❑ | 1 | 270Ω | red violet brown brown | red violet black black brown |
| ❑ | 1 | 200Ω | red black brown brown | red black black black brown |
| ❑ | 2 | 100Ω | brown black brown brown | brown black black black brown |
| ❑ | 2 | 1Ω | brown black gold gold | brown black black silver brown |
| ❑ | 1 | 10Ω 5W | not applicable | not applicable |

## Parts List

1 PC board, code 11111031, 68mm x 62mm
1 L8 ferrite toroid, 19 x 10 x 5mm (L1) (Jaycar LO-1230)
2 2-way 2.54mm terminal blocks (CON1, CON2)
1 3-way 2.54mm SIL header (JP1)
1 jumper shunt
2 8-pin IC sockets
1 2 x "D" cell holder
1 SPST power switch to suit (2A contacts) (S1)
1 300mm length (approx.) 1mm enamelled copper wire
4 M3 x 10mm tapped nylon spacers
4 M3 x 6mm pan head screws

**Semiconductors**

2 7555 CMOS timers (IC1, IC2)
1 MAX1676EUB step-up DC-DC converter (IC3) (Altronics)
1 1N5404 3A diode (D1)
2 BAT46 Schottky diodes (D2, D3) (Jaycar ZR-1141)
2 PN200 transistors (Q1, Q4)
2 2N3904 transistors (Q2, Q3)
1 3mm high-intensity red LED (LED1)
1 1W Luxeon Star LED (white, green, cyan, blue or royal blue)

**Capacitors**

2 100µF 50V low-ESR PC electrolytic (Altronics R-6127)
1 100µF 16V PC electrolytic
2 100nF 50V monolithic ceramic
2 100nF 50V SMD chip (0805 size) (Altronics R-8638)
3 10nF 63V MKT polyester
2 5.6nF 63V MKT polyester

**Resistors** (0.25W, 1%)

| | |
|---|---|
| 1 680kΩ | 1 6.8kΩ |
| 2 160kΩ | 1 3kΩ |
| 1 100kΩ | 2 470Ω |
| 1 62kΩ | 1 270Ω |
| 1 47kΩ | 1 200Ω |
| 1 27kΩ | 2 100Ω |

2 1Ω 0.25W 5%
1 10Ω 5W 5% (for testing)

**Trimpots**

1 1MΩ miniature horizontal trimpot (VR1) (Altronics R-2486B)
1 5kΩ miniature horizontal trimpot (VR2) (Altronics R-2479B)

**Miscellaneous**

Hot melt glue or neutral cure silicone sealant

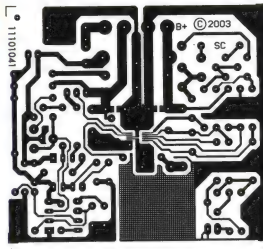



**Fig.10: the full-size PC board pattern. Check your board carefully for etching defects before installing any of the parts.**

You will probably find that it's easier to heat two or three leads at once. The idea is to remove all of the solder blobs and bridges, leaving bright and well-formed solder fillets between leads and pads.

As before, do not apply heat to any lead for more than two seconds and allow about 20 seconds between applications for the IC to cool! Once you've done that, remove all flux with the cleaning fluid and brush and inspect the result under a magnifying glass. Redo any joints as necessary.

Once you're happy with your work, use a multimeter to make sure that there are no shorts between adjacent pads and tracks. This step is very important; a hairline solder bridge can be difficult to spot by eye!

Before moving on to the top side of the board, solder the two 100nF chip capacitors in place (see Figs. 7 & 8) and install the insulated wire link. The link can be fashioned from a length of 0.7mm tinned copper wire insulated with heatshrink tubing or similar. You'll need to form a gentle bend into the link so that it doesn't obscure the holes for the capacitor leads. Trim the link ends flush with the surface on the top side of the board.

## Top side assembly

Now for the top side assembly. First, fit an M3 x 10mm tapped Nylon spacer to each corner of the PC board. This will help to protect the SMD parts while you're installing the remaining parts.

Using the overlay diagram as a guide (Fig.9), begin by installing all the wire links using 0.7mm tinned copper wire. Note that some of them go underneath components (IC1 & IC2, for example), so they must be installed first!

Next, install all of the 0.25W resistors, followed by diodes D2, D3 and ZD1. Be sure to align the cathode (banded) ends as shown.

All remaining parts can now be installed in order of height, leaving the large 100µF capacitors and inductor L1 until last. Be careful not to mix up the two different transistor types.

## Winding the inductor

The inductor (L1) must be hand-wound. To do this, wind 6.5 turns of 1.0mm enamelled copper wire onto the specified ferrite toroid. The wire must be wound as tightly as possible and spaced evenly over the core area (see Fig.9 and the photos).

The start and finish should be spaced about one turn apart. Trim and bend the wire ends to get a neat fit into the PC board holes. That done, use a sharp blade to scrape the enamel insulation off the wire ends. The ends can then be tinned and the completed assembly slipped into position and soldered in place.

You can now permanently fix the inductor to the PC board using a few blobs of hot-melt glue or neutral cure (non-acetic) silicone sealant.

Finally, install the two 100µF electrolytic capacitors. Note that they go in opposite ways around, so be sure to align the positive leads as indicated on the overlay diagram.

## Test and calibration

Don't be tempted to hook up your LED just yet! First, the supply must be checked for correct operation and the output current set.

To do this, first connect a 10Ω 5W resistor directly across the output terminals. Next, hook up your battery holder's flying leads to the input terminals, making sure that you have them the right way around. Use the overlay diagram (Fig.9) to determine the correct polarity.

Note that the leads to the battery holder should be kept as short as

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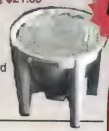

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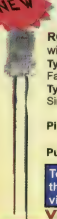

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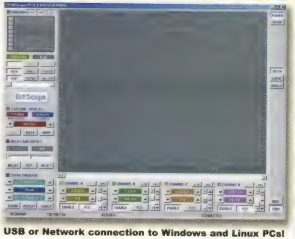

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possible. We'd also recommend replacing the light duty leads (supplied pre-wired on most holders) with heavy-duty multi-strand cable.

The next step is to install a jumper shunt on pins 2-3 of JP1 to disable brightness control and to set VR2 to its centre position. Now hold your breath and plug in a pair of fresh alkaline batteries.

Measure the voltage drop across the 10Ω resistor. If the supply is working properly, your meter should read near 3.5V. If it is much lower (say, around 2.3V), then the step-up converter is not doing its job. Assuming all is well, adjust VR2 to get 3.5V across the resistor.

## LED mounting

The Luxeon Star's emitter and collimating optics are factory-mounted on an aluminium-cored PC board. In most cases, no additional heatsinking is required. However, a small heatsink reduces junction temperature and therefore ensures maximum LED life.

Just about any small aluminium heatsink with a flat surface large enough to accommodate the Star's 25mm footprint can be pressed into service. For example, an old 486 PC processor heatsink would probably be ideal. A light smear of heatsink compound between the mating surfaces will aid heat transfer.

We've not provided any specific mounting details here, as they will depend entirely on your application. Keep in mind that the heatsink surface must be completely flat so as not to distort the LED's PC board when the mounting screws are tightened. You should also provide strain relief for the connecting wires.

Note that this supply is suitable for use with white, green or blue stars but not red or amber. This is because of the lower forward voltage of the latter varieties (2.3V min. versus 2.8V). With maximum input voltage, the output of the supply could exceed a red/amber LED's forward voltage, with the result being loss of regulation and probable damage to the LED.

## LED hook-up

Wire up your Star with light to medium-duty multi-strand cable. Try to keep the cable length under 150mm or so. A small copper "dot" near one of the corner pads indicates the anode (+) side of the LED.

Next, disconnect the 10Ω "test" resistor and replace it with the LED leads. That done, you can power up and measure the voltage drop across the paralleled 1Ω resistors. These are situated next to the output connector (see Fig.9). If necessary, readjust VR2 to get a reading of 175mV. As described earlier, this sets the LED current at full power to 350mA.

By the way, don't stare directly into the LED beam at close range, as it is (according to Luxeon) bright enough to damage your eyesight!

Note: the current calibration procedure described above should only be performed after installing a fresh set of alkaline batteries. If you're using a DC power supply instead of batteries, set the input voltage to 2.80V (never exceed 3.0V!)

## Brightness control

To use the brightness control function, move the jumper shunt to the alternate position (JP1, pins 1-2 shorted). By rotating VR1, it should now be possible to vary the LED intensity all the way from dim to maximum brightness.

If required, VR1 can be mounted away from the PC board. Keep the wire length as short as possible (say, no more than about 50mm) and twist the three connecting wires tightly together. If you're using a plastic case, then the metal body of the pot will probably need to be connected to battery negative to reduce the effects of noise pickup. SC

## Where To Get Parts & Stars

A complete kit of parts for this project is available from Altronics for $34.95 (doesn't include 1W Luxeon Star LED).

1W Luxeon Star LEDs are currently available from Prime Electronics on the web at **www.prime-electronics.com.au** or phone (02) 9746 1211. You can also get them from the Alternative Technology Association at **www.ata.org.au**, phone (03) 9388 9311. Detailed technical information on Luxeon Star LEDs can be obtained from the Lumileds web site at **www.lumileds.com**.

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# Antenna & RF preamp for weather satellites

**Here's the third article in our series on receiving and decoding the VHF APT signals from weather satellites. It describes an easy-to-build "turnstile/reflector" antenna plus an RF preamp designed to mount up near the antenna to improve the signal-to-noise ratio.**

**By JIM ROWE**

AS MENTIONED IN the first of these articles, you don't need a high-gain tracking antenna to receive the 137.5MHz or 137.62MHz APT (automatic picture transmission) signals from the polar orbiting weather satellites. A fixed antenna will do the job but you do need one with an approximately hemispherical reception pattern. It also needs to be capable of receiving circularly-polarised signals, because the signals from the weather satellites use this format.

There are three main antenna types that meet these requirements but two of them – the quadrifilar helical (QFH) antenna and the Lindenblad – are not at all easy to build. The antenna we're describing here is the third type which is usually described as a "turnstile/reflector" (T/R) or "crossed dipoles with reflector" antenna. In fact, we decided to go with this type after building a Lindenblad and getting quite disappointing results.

As a bonus, the T/R antenna is much easier to build than the other two types and is also less critical about the type of roof it's mounted above - although it should still be mounted as high as

## Antenna Parts List

- 4 500mm lengths of 10 x 3mm aluminium strip
- 1 82 x 80 x 55mm polycarbonate sealed box
- 1 75 x 76 x 52mm PVC junction box with one inlet
- 1 PVC conduit thread adaptor
- 1 73 x 75mm rectangle of 3mm perspex sheet
- 4 25mm long untapped spacers
- 4 32mm long M3 machine screws
- 8 M3 x 10mm machine screws with nuts & lockwashers
- 4 M3 solder lugs
- 2 2470mm lengths of 10 x 3mm aluminium strip
- 2 1300mm lengths of 16 x 3mm aluminium strip
- 1 U-clamp and V-block assembly
- 1 2.4mm length of 32mm OD gal mast pipe (optional)
- 6 M4 x 12mm machine screws with nuts & lockwashers
- 1 360mm length of 75Ω coaxial cable (phasing loop)
- 1 360mm length of 50Ω coaxial cable (matching section)
- 1 75Ω coaxial 'TV' plug, line type (Belling-Lee)
- 1 75Ω coaxial 'TV' socket, line type (Belling-Lee)
- 1 length of 75Ω coaxial cable (to suit)

possible, so that it has the largest possible unobstructed view of the sky in your location.

As you can see from the photo, the antenna is fairly simple. The "active" elements consist of two horizontal half-wave dipoles which are crossed (ie, at right angles to each other), with their feed points connected together via an electrical quarter-wave length of 75Ω coaxial cable. This introduces a 90° phase shift at the reception frequency and it's this phase shift that allows the antenna to receive circularly-polarised signals.

The active elements are mounted roughly 0.3 of a wavelength (0.3λ) above a pair of matching crossed reflectors in a square frame. These reflectors give the antenna a roughly hemispherical reception pattern, which can be modified to some extent by varying the spacing between the reflectors and the active elements. Reducing the spacing gives more gain directly upwards and poorer coverage at lower angles. Conversely, increasing the spacing reduces the vertical gain – eventually to a null – and also gives other lobes and nulls.

We used 10 x 3mm aluminium strip to make the active elements and also to make the frame that's used to secure the reflectors. The reflectors themselves were made from slightly stronger 16 x 3mm aluminium strip. The construction details should be fairly clear from the diagrams – see Figs.1 & 2.

As shown on Fig.1, the active elements are all 500mm long. This gives dipoles a whisker (1.5%) shorter than they should theoretically be for an end-corrected half-wavelength at 137.5MHz. However, it also means that all four elements can be cut from a standard 2m length of the aluminium strip. The difference is not significant in practice.

The inner ends of each dipole element are mounted on a 73 x 75mm rectangular plate of 3mm perspex sheet, which is cut into a "fat" cross shape and drilled as shown. The 3.5mm holes are used for mounting the dipoles on the perspex plate (using 12mm x M3 screws and nuts) and also for mounting the complete assembly inside an 82 x 80 x 55mm polycarbonate box. The box specified has a sealing groove and strip around the lid for weatherproofing.

The complete assembly is held inside the box using four M3 x 32mm machine screws, which mate with the threaded inserts moulded in the bottom of the box. Untapped spacers 25mm long ensure that the assembly sits so that the active elements leave the box (via small slots cut in the centre of each side) with their top surfaces very close to the top edge of the box sides. Then just before the box lid is fitted, small strips of neoprene or rubber are placed on the top of each element, so the box sealing is preserved.

The larger 6.5mm holes in the perspex plate are to accept the two ends of the cable phasing loop, along with the end of the 50Ω matching cable section. Because the phasing loop is a little too long to be coiled up inside the box, it loops out and back in again through a pair of holes drilled in the bottom of the box (about 40mm apart). The holes should be made only just large enough to accept the 75Ω phasing cable, so it won't be easy for moisture to find its way in. You might also like to seal around the cables with neutral-cure silicone sealant when the antenna is complete.

Like the phasing loop, the matching cable section is 360mm long. This represents a quarter wave at 137.5MHz, corrected for the cable's velocity factor (0.66). However, the matching section is cut from 50Ω cable, which makes it act as an impedance transformer. The 37.5Ω impedance of the two dipoles in parallel is thus transformed into an effective 75Ω impedance, so that the signal can be fed down to the preamp or receiver via standard 75Ω cable.

The 50Ω matching cable doesn't exit from the box through another external hole but instead passes down through a shortened PVC cable thread adaptor. This adaptor is also used to couple the top box to a 75 x 76 x 52mm single inlet plastic junction box, used in turn to mount the combination on the top of the 32mm mast. It also provides an "access hatch" to the 75Ω connectors which couple the 50Ω matching cable to the main 75Ω downlead, just down inside the mast.

Initially, we were going to mount the preamp inside this lower box as well but this would have been a very tight squeeze. It would also have meant trying to coil up the 50Ω matching cable inside one or other of the two boxes, which would be tricky as well.

Note that the PVC cable thread adaptor which is used to couple the two boxes together is shortened by cutting off most of the sleeve section which is normally cemented over the end of a conduit. By cutting this section off, you're left with a large-diameter hollow PVC "bolt", with a mating PVC nut.

As shown in Fig.1, the reflector elements are bent up from two 1300mm lengths of the 16 x 3mm aluminium strip. Each piece is bent into an "L" shape, with main arms 605mm and 645mm long and 50mm return arms at each outer end. The two longer arms are then overlapped in the centre and both drilled with a pair of 6.5mm holes, to take the threaded ends of a standard U-clamp bolt.

This bolt and its matching V-block are then used not only to hold both

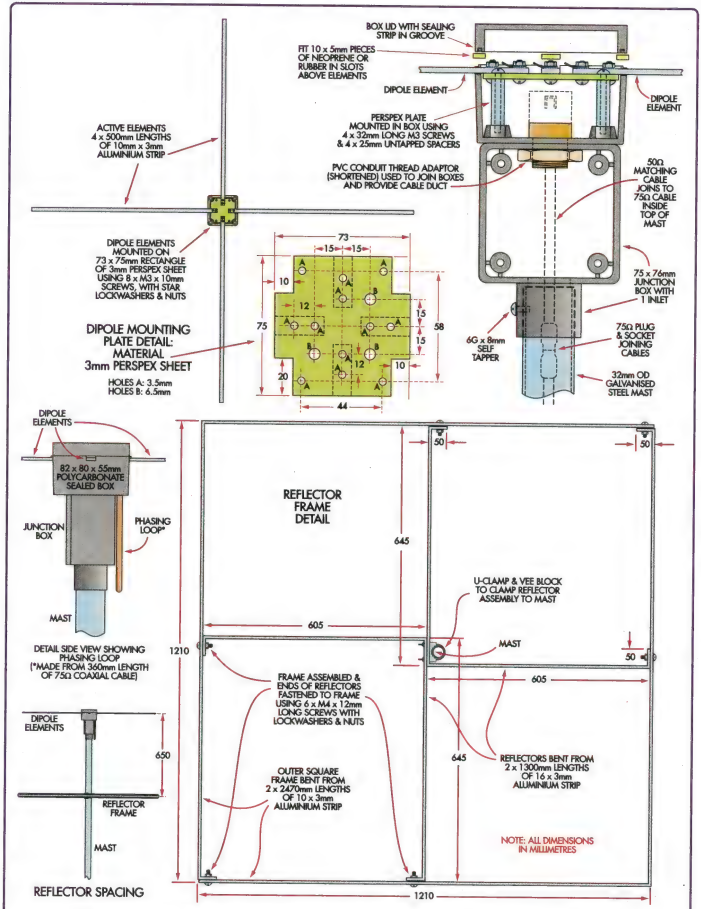



**Fig.1: follow this diagram to manufacture the parts and assemble the turnstile/reflector antenna.**

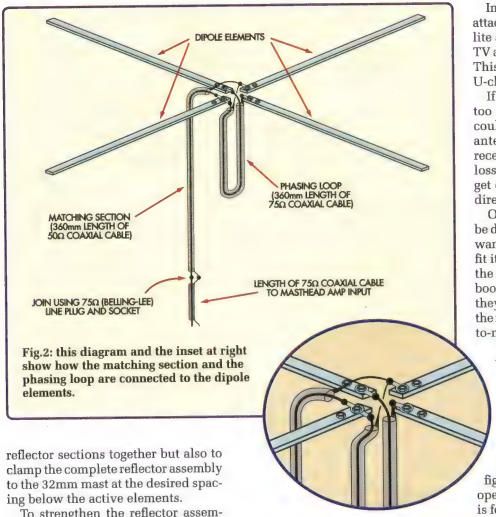



**Fig.2: this diagram and the inset at right show how the matching section and the phasing loop are connected to the dipole elements.**

reflector sections together but also to clamp the complete reflector assembly to the 32mm mast at the desired spacing below the active elements.

To strengthen the reflector assembly and also to partially enhance the reflectors for lower reception angles, the reflectors are enclosed in a 1210 x 1210mm square of 10 x 3mm aluminium strip. This is formed from two 2470mm lengths, each bent into an "L" shape with the main arms 1210mm long and a 50mm return at one end. The two halves are then assembled into a square using two 12mm x M4 screws plus nuts and lockwashers, while four more 12mm x M4 screws are used to bolt the ends of the reflector arms to the centre of each side of the square. It's all quite easy to build and assemble.

## Mounting the antenna

As mentioned before, the completed antenna should be mounted as high up off the ground as you can manage, so that it gets the largest unobstructed view of the sky. The 137.5MHz weather satellite signals are not particularly strong and are attenuated even more if they have to pass through heavy cloud, tree canopies, etc.

In some cases, you might be able to attach the mast of the weather satellite antenna to the upper part of your TV antenna's mast, to get extra height. This can be done using another pair of U-clamp/V-block assemblies.

If your receiver isn't going to be too far away from the antenna, you could now try running the main 75Ω antenna downlead directly to the receiver's input. Provided the cable losses aren't too high, you just might get quite acceptable results from this direct connection.

On the other hand, the results might be disappointing, in which case you'll want to build up the RF preamp and fit it into another weatherproof box at the base of the mast. That way, it can boost the strength of the signals before they go down the main downlead to the receiver, thus improving the signal-to-noise ratio quite significantly.

OK, let's now move on to describe the RF preamp.

## The RF preamp

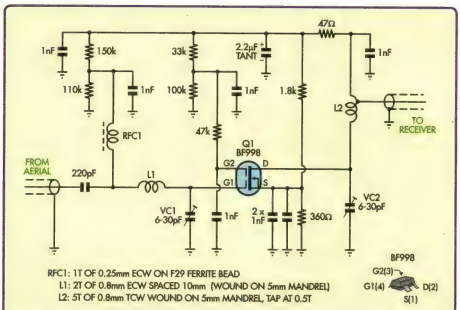
The main requirements for this type of preamp are that it should provide around 15-20dB of stable amplification at 137.5/137.62MHz, with a low noise figure. It should also be capable of operating from a 12V DC supply which is fed up the downlead cable from the receiver.

This may all sound easy enough but it's trickier than you might think. In fact, we tried out a number of different configurations in developing this project but in most cases they gave unsatisfactory results. Basically, they either didn't provide enough gain and/or were too noisy, or they were too hard to keep stable.

One simple design we tested used a Mini Circuits MAR-6 microwave amplifier IC, as used in many masthead amplifiers for TV. This was stable

## Table 1: Resistor Colour Codes

| ❑ | No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|---|
| ❑ | 1 | 150kΩ | brown green yellow brown | brown green black orange brown |
| ❑ | 1 | 110kΩ | brown brown yellow brown | brown brown black orange brown |
| ❑ | 1 | 100kΩ | brown black yellow brown | brown black black orange brown |
| ❑ | 1 | 47kΩ | yellow violet orange brown | yellow violet black red brown |
| ❑ | 1 | 33kΩ | orange orange orange brown | orange orange black red brown |
| ❑ | 1 | 1.8kΩ | brown grey red brown | brown grey black brown brown |
| ❑ | 1 | 360Ω | orange blue brown brown | orange blue black black brown |
| ❑ | 1 | 47Ω | yellow violet black brown | yellow violet black gold brown |




## WEATHER SATELLITE VHF PREAMP

**Fig.3: the VHF preamplifier circuit is based on a BF998 dual-gate MOSFET and is powered from a 12V DC supply which is fed up via the down-lead.**

enough but it didn't provide enough gain and for this type of application it was relatively noisy as well.

We also tried a design based on a BF998 dual-gate MOSFET that was very similar to the RF stage in the Weather Satellite Receiver described last month. This gave enough gain and was much quieter as well but it was very difficult to "tame" – it would oscillate at the drop of a hat, despite all kinds of shielding and extra bypassing.

Eventually, after much web research, experimenting, frustration and tearing of hair (what little hair the author has left!), we finally arrived at the configuration shown here. It still uses a BF998 MOSFET but has a somewhat different input coupling circuit which allows the preamp to be peaked up for quite acceptable gain and a low noise figure (below 1dB), while at the same time being much more stable.

As shown in Fig.3, the BF998 is used as a cascode RF amplifier. The incoming RF signal (from the antenna) is fed to gate 1 via a 220pF input coupling capacitor and then via L1 and VC1, which form an input tuning/matching network. Gate 1 is also fed the correct DC bias voltage via RF choke RFC1 and a voltage divider consisting of 150kΩ and 110kΩ resistors.

Gate 2 of Q1 is biased to achieve maximum gain. Its bias voltage is derived from a 33kΩ/100kΩ voltage divider and this is fed to gate 2 via a 47kΩ decoupling resistor. Q1's source is also provided with the correct bias voltage via a 360Ω self-bias resistor and this is fed with some additional current via a 1.8kΩ resistor.

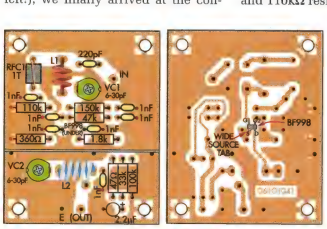
Q1's output is tuned by L2 and VC2 in the drain circuit. The RF output from the preamp is then derived from a tap near the "cold" (to RF) end of L2, to provide an approximate match for the 75Ω output cable to the receiver. At the same time, the tap delivers the +12V DC supply to run the preamp, which is fed from the receiver via the down-lead.

Note that there are quite a few 1nF bypass capacitors throughout the circuit. These ensure that points like the "G2" and "S" leads of Q1 and the "cold" ends of RFC1 and L2 are held firmly at ground potential for RF, which is necessary for stability. These capacitors should be either disc ceramic or multilayer monolithic ceramic types and their leads should be kept as short as possible.

### Building the preamp

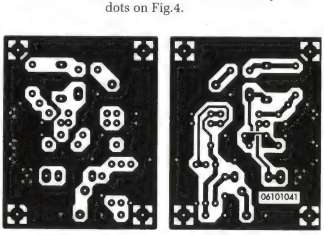
The preamp is built on a very small double-sided PC board coded 06101041 and measuring 41 x 51mm. All parts except the BF998 MOSFET are mounted on the top of the board, while the MOSFET mounts underneath because it's a surface-mount device. The location and orientation of all parts is shown in Fig.4.

Note that some component leads have to be soldered on both sides of the PC board, as indicated by the red dots on Fig.4.




ABOVE BOARD UNDER BOARD

**Fig.4: the PC board assembly. The red dots indicate leads that must be soldered on both sides of the board.**




TOP COPPER BOTTOM COPPER

**Fig.5: check your PC board against these full-size etching patterns before installing any of the parts.**

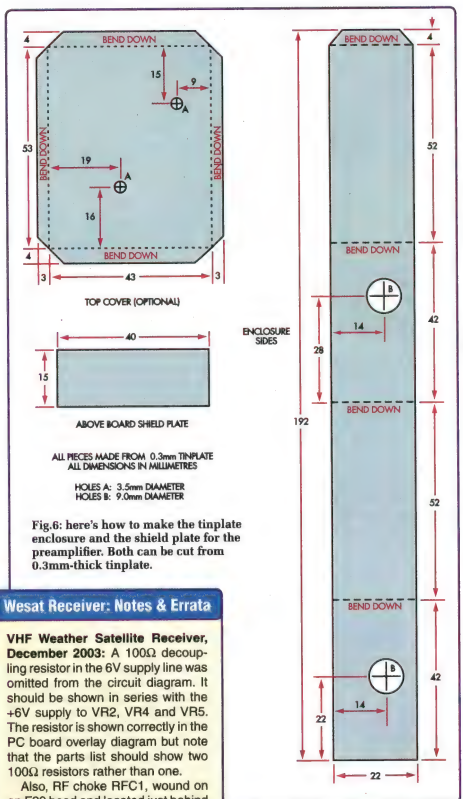



**Fig.6: here's how to make the tinplate enclosure and the shield plate for the preamplifier. Both can be cut from 0.3mm-thick tinplate.**

## Wesat Receiver: Notes & Errata

**VHF Weather Satellite Receiver, December 2003:** A 100Ω decoupling resistor in the 6V supply line was omitted from the circuit diagram. It should be shown in series with the +6V supply to VR2, VR4 and VR5. The resistor is shown correctly in the PC board overlay diagram but note that the parts list should show two 100Ω resistors rather than one.

Also, RF choke RFC1, wound on an F29 bead and located just behind the RF input socket, should be wound from two turns of 0.25mm ECW, not three turns of 0.5mm ECW. The 2.2nF ceramic bypass capacitor just to the right of RFC1 on the board should also be omitted. Both these changes improve performance when an RF preamp is being used.

Both L1 and L2 are air cored but are wound on a 5mm drill shank or similar 5mm OD mandrel. L1 is wound using 0.8mm enamelled copper wire (ECW) and has only two well spaced turns, while L2 is wound using 0.8mm tinned copper wire (TCW) and has five spaced turns. The tap on L2 is spaced half a turn from the end that is "cold" for RF – ie, the end furthest from VC2.

The only other coil in the circuit is RFC1 and this is wound on an F29 ferrite bead, using only a single full turn of 0.25mm ECW.

To ensure stability, a shield plate should be fitted across the top of the board in the position shown. This plate is cut from 0.3mm tinplate and measures 40 x 15mm. You'll find that the PC board has three 1mm diameter holes in this location, to take 1mm PC board terminal pins. Fit these first, then use the pins as "posts" to support the shield plate when it's soldered to them.

The board also has holes for: (1) a terminal pin at the preamp's input, (2) a pin for the tap wire for L2 and (3) a pin for the preamp's output. You can use these pins for connecting coaxial cables directly to the board, if you wish.

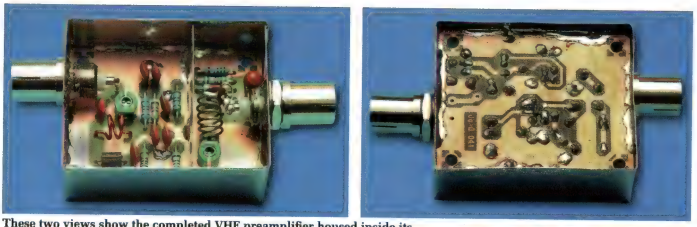
However, as you can see from the photos, it's also possible to enclose the four sides of the preamp with a simple box made of tinplate, which provides some shielding and also supports a pair of panel-mounting 75Ω "TV" sockets (ie, the type formerly known as "Belling-Lee" sockets). These make the input and output connections a little more convenient.

### Tinplate enclosure

The dimensions of the tinplate enclosure are shown in Fig.6, along with the hole locations and sizes for the two sockets. Notice that both sockets are mounted in the ends of the enclosure by soldering their outer threaded sections directly to the box ends, on the inside of the tinplate. This is done for two reasons: (1) it gives a more reliable earth connection; and (2) there isn't room to fit the nuts inside the enclosure anyway.

Note also that the nut for the output socket is actually fitted to the socket and tightened firmly before the socket is soldered into the enclosure, to act as a spacer. This ensures that this socket doesn't protrude inside the case by its full threaded length.

The centre pin of both sockets is cut short, to make sure they clear other components. The input socket's centre pin is then soldered directly to the PC board terminal pin marked "IN", while the output socket's pin can be connected directly to coil L2 via a very short length of tinned copper



**These two views show the completed VHF preamplifier housed inside its tinplate enclosure and fitted with 75Ω TV sockets for the input and output connections. Note the short wire link connecting directly from the centre pin of the righthand (output) socket to the tap on coil L2 (ie, the tap is not taken to a terminal pin if the socket is is fitted).**

wire, to make the tap connection (in this case, the "OUT" pin is not fitted to the board at all).

If you elect to provide the preamp with this simple tinplate enclosure/socket support, fit the board into the enclosure so that the top of the shield plate is level with the top of the enclosure sides. That done, run a fillet of solder along the edges of the board on both the top and bottom, to bond the tinplate to both of the board's earthy copper layers. This not only holds it all together but also helps ensure stable operation.

## Checkup & tuning

When your preamp is complete, connect its output to the input of the receiver with a length of 75Ω coaxial cable. That done, turn on the receiver and quickly check a few voltages in the preamp with your DMM, to make sure it's working correctly. You should be able to measure about +11.8V at the cold end of L2 and also at that end of the 22Ω decoupling resistor.

You should also be able to measure about +4.7V at the junction of the 150kΩ and 110kΩ bias resistors for G1, and +4.9V or thereabouts at the top of the 360Ω source resistor. Finally, you should get about +8.8V at the junction of the 100kΩ, 33kΩ and 47kΩ resistors (ie, feeding G2 of Q1).

If all of these voltages are close to the values given, your preamp should be working correctly. Assuming that's the case, switch the receiver to one of the two satellite reception channels (ie, 137.5MHz or 137.62MHz), then connect the preamp's input to your signal generator via a suitable cable and set the generator to the same frequency.

Now connect your DMM (set to the 5V DC range) across the 390kΩ RSSI load resistor in the receiver, so you can use it as a signal strength meter. The signal generator can then be set for about 2-3μV of output.

Next, turn up the receiver's RF gain control to about halfway. You may not be aware of any signal at this stage but try adjusting trimmer VC2 in the preamp slowly using an insulated alignment tool. Listen carefully for a signal and also watch the DMM carefully to monitor the signal level.

Somewhere near midway in the trimmer's adjustment range, you should find the signal and be able to set VC2 for a peak in both the received tone and the DMM reading. If the DMM reading rises much above 2.5V, you may need to reduce the signal generator's output to bring it down below this level again.

When the correct setting has been found for VC2, leave it alone and turn your attention to VC1. By adjusting this carefully (again using an insulated alignment tool), you should be able to find another signal peak and a minimum for the accompanying noise.

Once you have set VC1 carefully for this second peak, your preamp is tuned up and ready to be connected into the antenna downlead at the base of the mast. We suggest that you fit the preamp into another small polycarbonate box – ie, the same type as used for the antenna's active elements, so it can be sealed to keep moisture out.

Both the input and output cables should pass through close-fitting holes drilled in the bottom of the box, to reduce the likelihood of moisture finding its way inside. As before, it's a good idea to run some neutral-cure silicone sealant around both cable exits, to ensure that the moisture is really kept out.

Happy weather satellite signal reception! **SC**

## Preamp Parts List

1 PC board, code 06101041, 41 x 51mm (double sided, but not plated through)
1 F29 ferrite bead (for RFC1)
1 short length 0.25mm enamelled copper wire for RFC1
1 short length 0.8mm enamelled copper wire for L1
1 short length 0.8mm tinned copper wire for L2
5 PC board terminal pins, 1mm diameter
2 75Ω coaxial "TV" sockets (Belling-Lee), panel mount
1 40 x 15mm piece of 0.3mm tinplate for top shield
1 40 x 4mm piece of 0.3mm tinplate for bottom shield
1 192 x 22mm piece of 0.3mm tinplate for enclosure

**Semiconductors**
1 BF998 dual-gate MOSFET (Q1)

**Capacitors**
1 2.2μF 35V TAG tantalum
7 1nF disc ceramic
1 220pF disc ceramic
2 6-30pF trimcaps, small (VC1, VC2)

**Resistors** (0.25W 1%)

| | |
|---|---|
| 1 150kΩ | 1 33kΩ |
| 1 110kΩ | 1 1.8kΩ |
| 1 100kΩ | 1 360Ω |
| 1 47kΩ | 1 47Ω |

# SERVICEMAN'S LOG

## Born in the UK, dead in Oz

**Foreign sets that were not originally sold in Australia can be a real problem when it comes to servicing. Service manuals are often difficult to obtain and things can get even more complicated when a modification kit has been released.**

Last month, I wrote about a completely foreign Sony colour TV set that had found its way to the Antipodes from Europe. As a result, it was difficult to obtain a service manual for it or any service information at all.

This month, I have another in the same vein but this TV is a Panasonic TX-29AD5050FB, purchased locally and owned by Melissa, a near neighbour. The set is a 100Hz Super Digital Scan model employing a Euro 3H chassis (circa 1997). And until it arrived in my workshop, I had never heard of such a model or chassis. However, it all eventually made sense when I saw a label saying "Made in UK".

The set was dead and with the back off, I soon found out where the problem lay – after all, Panasonic TVs do have their similarities. The problem was no vertical deflection due to IC451 (Philips TDA8350Q/N5) being faulty. In addition, the "micro button" fuse F352 (1.25A) was open circuit.

I replaced the IC and fuse and the picture was restored. However, it now had geometrical distortions in its scan. There was pincushion distortion and lack of height, plus retrace lines and top foldover.

I didn't have the remote control (EUR51923 – I believe), nor the instruction booklet – not that that would give you any information on how to get into the service mode. However, from a service manual for a similar model, I found that you can get into the service mode by setting the Bass to maximum and the Treble to minimum, then simultaneously pressing the Reveal Status and Volume down buttons on the remote control and the TV set respectively.

This brought up the "Self Check" menu which informed me that everything was OK and that the Option Hex Codes were 09, 73, E6, IF, BB, BF and 03. However, none of this helped in diagnosing the fault. Nor could I make any adjustments without the correct remote control and service manual.

Next, I spent a lot of time checking the voltages around the 13-pin deflection IC (IC451). There were two power supply rails, 50V and 16V, feeding this IC across diode pump D453. The 16V went to pin 4 and actually measured 18V, while the 50V rail went via R568 and measured 20.3V at pin 8. I found all the other voltages to be roughly as I would have expected but nearly all the waveforms around the IC exhibited a small amount of distortion.

Lacking any real clues at this stage, I initially decided to replace all the electrolytic capacitors (C452, C453, C455 and C560) around this stage and even swapped IC401 (TDA9151B). Unfortunately, this made no difference and I really couldn't proceed any further without a circuit diagram.

### Items Covered This Month

- Panasonic TX-29AD5050FB TV set (Euro 3H chassis).
- UEC DSD700 and UEC IRD642 satellite receivers.
- Sony KV-ES34M31 TV set.

Fortunately, Panasonic Australia were able to lend me a circuit diagram of the Euro-3HW but for a model TX-W36D3DP. This was a great help, despite the fact that there were distinct differences between this diagram and the set I was working on. Also, there were no voltages or waveforms marked on the circuit for me to compare with those from the set.

I was about to give up when I decided to surf the net and do a search using Google. The trick here is to ask the right question, so I began by typing in "Panasonic Euro 3 faults" and was immediately rewarded with a repair tip. This mentioned a modification kit (TZS8EK003) that should be fitted when replacing the field chip.

Armed with this information, I went back to Panasonic Australia who immediately put in an order to Panasonic UK. Nothing happened for a very long time and when the client finally went ballistic, it turned out that the man dealing with it in the UK had died (truly) before he had completed the order. Well, if that's not a good reason, then I don't know what is and so the order was re-submitted. At the same time, I also tried to obtain a kit direct from the UK through advertisements in "Television" magazine (one of their advertisers, Grandata, had a kit called "PANKIT 2" which looked as though it might fit the bill).

Well, we sat back and waited and waited. Nothing happened, so after about a month, I started to chase the orders up. The first order had got lost in the system and the second (to Grandata) had got lost in the post! I re-ordered again but the frustration was getting to me. All I needed to know was what the modifications were and then I could source the bits locally.

I tried Grandata to see if they had any information but they are strictly a wholesale supplier. And as might be expected with a foreign set, Panasonic Australia didn't have any information either, so I tried to get the information

from Panasonic UK. However, this initially proved tricky as there's no email address on their website.

Eventually, I came across a page that lets you contact them. This involves typing in a message plus your address but as soon as "Australia" is entered in the country field, it automatically flicks you from the UK website to **www.panasonic.com.au**.

In the end, I managed to fool the system by putting all my address into one field. I then emailed them my enquiry regarding the modification kit, explaining that I was an authorised Panasonic technician. This is how I met "George"; his response, for Panasonic UK, was:

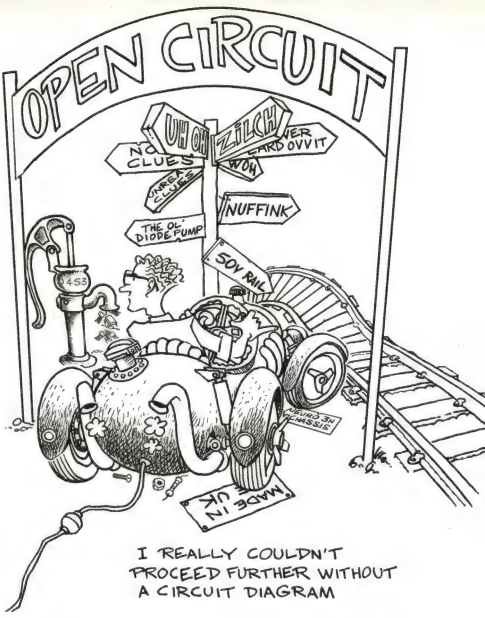
"PROBLEM: RESOLUTION. We would explain that we do not recommend that customers effect their own repairs. Instead, we suggest that the product is submitted to an authorised Service Agent for attention"; and "please be advised that for safety reasons Panasonic UK will not be able to provide any technical guidance or assistance".

However, I wasn't about to be put off that easily. I shot back a reply, reiterating that Panasonic Australia was faced with trying to repair a Panasonic UK manufactured product and could do with a bit of help from the people that made it. Eventually, after staying up late, the best I got was an address to buy parts from (SEME Ltd) and a telephone number. But there was no email ordering here – it was going to be snail mail again and we had already been waiting now for over five months.

And so, not to be deterred, I continued emailing "George" from Panasonic UK until finally – as a special concession – he gave me a little useful(?) information: "The F in the suffix (TX-29AD50FB) denotes the model is French. I am unable to disclose technical information on this model because we do not have any as it is not a UK model".

I mean, what can you do? Life is too short. I felt like emailing him a photograph of the compliance plate on the back of the set with words "Made in UK" emblazoned upon it. But I knew I was dealing with a Mr Plod.

A search through "Television" magazine didn't reveal much on this set either. The magazine had published articles on servicing the Euro 1 and 2 Chassis and the Euro 4 chassis (but not the Euro 3), so these had no bearing on this problem.




In the meantime, Panasonic Australia had had some success, and came up with the TAA8350Q/N6 vertical deflection IC as an improvement on the "N5" chip. I duly fitted this new IC but it made no difference to the problem. Finally, things came to the crunch – either we fix the set immediately or Panasonic Australia was going to have to supply a brand new TV to Melissa (not, I hasten to add, the same model).

An then, there was a minor miracle of sorts. A colleague at the repair agency (I do regular contract work for them) had, unbeknownst to me, decided to check out the set for himself. And so it was that I was utterly amazed when I returned after an absence of several hours to find he had fixed the problem completely!

I mentioned earlier that there is a 50V feed via R658 to pin 8 of IC451. There was 20.3V on this pin but, as I found out later, it should have been much higher because R568 is only 33Ω. In fact, this ceramic fusible resistor was open circuit. Replacing it increased the voltage on pin 8 to approximately 45V and fixed up all the symptoms!

My colleague, although uncharacteristically modest on this occasion, is usually arrogant enough without being told he did well to find what I had overlooked – so I didn't! Perhaps I should have got him to deal with "George"!

However, all was not as it seemed, as I discovered only this very morning. In fact, the credit was due to another Panasonic technician from Queensland who had been asked to assist with yet another of these sets that had been in

someone else's workshop for three months (talk about parallel lives – it could have been me!). Anyway, the set was moved to his workshop and it was he who discovered the cause – in just about 15 minutes flat!

Just as well I didn't waste any praise on my colleague!

The set went back to Melissa and ironically enough, only one day later, my PANKIT 2 finally arrived from the UK. This kit includes the updated TDA8350Q/N6 (IC451), while C453 is now changed to 10µF 160V (previously it was 100µF 63V). In addition, F351 is now a 10Ω resistor, there is a replacement for F532 (which isn't fitted in this set) and ironically a brand new 33Ω 0.5W resistor to replace R568!

## Satellite receivers

I have been repairing satellite receivers for a while now and have recently encountered two interesting cases.

The first was two UEC DSD700s set up for Impajah and 7 Central in a block of units in the central business district (CBD). They were installed with a bank of several others, plus some other sophisticated "channelised" distribution amplifiers which were kept in a small service cupboard on the seventh floor.

The problem was caused by lack of ventilation and the heat generated in such a small enclosure which gave the symptom of digital patterning. To begin with, as soon as the problem started, it was realised that this cupboard was getting too hot and so cooling fans and ducts were installed but the damage had already been done.

Removing the covers back in the workshop revealed two boards, one for the switchmode power supply and the other for the receiver circuitry. And the latter was covered with about 50 of sub-miniature surface-mounted electrolytics – the type that give so much trouble in video cameras and the like.

Now that the unit was no longer in its hot environment, the patterning effect wasn't so bad. However, a quick blow wave with the hairdryer really brought the symptoms on strongly. With the aid of some freezer, it didn't take long to pinpoint the culprit as C113 (10µF 16V) next to one of the large microprocessor chips.

The other models that came in were also made by UEC but this time they were IRD642s and both were dead.

I checked what I thought was all the diodes by measuring the continuity on the solder side of the board. I also checked the electrolytics for leakage with my ESR meter before changing the IC zener (TL431C, IC3) and then IC1 (TOP225-1). None of these had any effect and the switchmode power supplies continued to "tick" (or pulsate), even when they were unplugged from the receiver.

Lacking any information on these units, I just had to get some help from somewhere. After a lot of searching on the Internet, I discovered that Nationwide Antennas were the agents for UEC and after speaking to their service manager, I was told it was extremely likely to be the extra diode fitted between the positive output of the bridge rectifier positive and the cathode of D8 via a 10Ω resistor.

He was of course spot on – it was short circuit. The reason I had missed it was because it was mounted on the component side as an extra "add-on" afterwards, so I wasn't able to measure it from the solder side of the board.

The diode was a P1.5KE220, which is a special 220V 6.8A quick response device. Perhaps if it was rated at 240V it wouldn't fail quite so often!

Incidentally, the service manager also pointed out that the digital interference patterning was usually caused by dry joints on the large microprocessor ICs.

## New cabinet

An electrician called me out to replace the cabinet for his Sony TV.

What had happened was that a good friend (at that time) was helping him to move his 1999 $4000 Sony KV-ES34M31 (AG3 chassis) to another corner of his lounge room. However, his (now ex) mate let go of his end of this 84kg 80cm TV set which landed heavily on its front bottom righthand corner, badly damaging the cabinet.

Fortunately, the picture tube was not damaged (thank goodness, at $1900 for a new one!). Even the vulnerable shadow mask which normally shifts, resulting in incurable purity errors, was undamaged and the picture was still excellent. Even so, I checked the self-diagnostic system first to make sure everything was OK.

I decided that it was better to replace

the cabinet in his home rather than carry the set to and from the workshop. The only problem was that the spare parts list did not show the front cabinet assembly, or "freznet" as Sony calls it, in the service manual, even though there is a picture of the assembled unit in the exploded diagram.

Eventually, I discovered that you are expected to "knit" your own cabinet from individual sub-panel assemblies, as shown on page 179 of the service manual. The reason is not immediately obvious until you do the bean counting. The average price of each panel is $260 (ouch!), thus making it over $1300 for five panels. And that doesn't include brackets, corner blocks and trim which often are not even shown in the parts list (even the back costs $325).

Anyway, the damage seemed to be confined to the base plate, the bottom and righthand frame sub-assemblies and the back. We decided that the base plate and back weren't worth replacing, considering the amount of visible damage and the replacement cost, and settled on replacing the two remaining parts.

First, we removed the back and loudspeakers and I then unclipped and unplugged the chassis. We then removed the picture tube, making sure it was fully discharged(!). After that, it was simple to dismantle the rest of the cabinet until we reached the offending parts.

The bottom frame sub-assembly was a solid piece of aluminium which was badly buckled, while the right frame was bent at the edges. These two alone would cost $566.06, so my client said he would try taking them to a panel beater first before deciding whether I should order the new parts (none are ex-stock).

This turned out to be an excellent decision as a really beaut job was done by an expert and you could hardly tell that it had been damaged.

Reassembling the telly was more stressful than disassembling it but eventually we worked out what went with what. It was difficult to work out where some of the earth leads went, and there was an additional unmarked plastic assembly that fitted under the top control panel that wasn't mentioned in the service manual.

Finally, we switched the set on and everything looked just great. And my client had saved a fortune by going to the panel beater! **SC**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# The World's Smallest Flying Microrobot

**Japan's Seiko Epson Corporation** has developed what their research suggests is the world's smallest "Micro Flying Robot", or uFR.

The 8.9 gram machine was built to demonstrate the micromechatronics technology that the company has cultivated over the years.

It is also intended to allow development of component technology applications and explore the possibilities for microrobots.

The uFR has the world's highest power-to-weight ratio (according to Epson research) and includes a low power consumption wireless module (again, according to Epson, the lowest in the world), mid-air control technology and a centre-of-mass movement control achieved through a linear actuator circuit.

Epson has developed and marketed a family of microrobots known as the EMRoS Series, beginning with the "Monsieur" model put on sale in 1993 and currently listed in the Guinness Book of Records as the world's smallest microrobot.

EMRoS stands for Epson Micro Robot System. The series consists of Monsieur (1 $cm^3$ in volume; 1993); Nino (0.5 $cm^3$, 1994); Ricordo (1 $cm^3$; equipped with a recording and playback function; 1995); and Rubie (1 $cm^3$; equipped with a capricious wandering function; 1995). All are autonomous travelling robots that chase a light source.

In April 2003 Epson developed Monsieur II-P, a prototype microrobot which operates on an ultra-thin, ultrasonic motor and a power-saving Bluetooth module that allows multiple units to simultaneously remote controlled.

Epson even put together a suite of these robots to create the world's smallest full-blown robot ballet theatre.

It might sound like a lot of fun but Epson are playing a pioneering role in research and development relating to microrobots and component technology applications. Sales of the EMRoS series have been discontinued and there are no plans to produce or market the new uFR.

## General Specifications

| | |
|---|---|
| Power supply: | 3.5V |
| Power consumption: | 3W |
| Diameter: | About 130mm |
| Height: | About 70mm |
| Levitation power: | About 13 g/f |
| Total weight: | About 8.9 g |
| Wireless module/control units: | About 2.5 g |
| Sensors: | About 0.9 g |

## How does it fly?

A pair of contra-rotating propellers powered by an ultra-thin, ultrasonic motor with the world's highest power-weight ratio create the lift required.

These can be balanced in mid-air by means of the world's first stabilising mechanism using a linear actuator.

Micromechatronics has been brought together in high-density mounting technology to minimise the size and weight of the circuitry's control unit.

By developing the uFR, Epson has demonstrated the possibility of expanding the activity range of microrobots from two-dimensional space (the ground) to three-dimensional space (the air).

Epson intends to use the uFR to feel out the reactions of visitors, discover and test problems related to microrobots and to further concentrate its efforts on advancing its original micromechatronics technology and cultivating applications to meet future needs. **SC**

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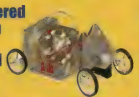
# Happy New Year

January 04 ISSUE

**A Water Powered Model Car, an Alternative Energy Model House and much more!**



See our great new range of educational and experimenters kits inside!

**SHORT CIRCUITS 2 IS HERE!**
**The wait is over. There are over 20 projects available, all ideal for anyone learning electronics!**

See the back page for more details.

**The ultimate in quality & reliability when it comes to gas powered soldering products and at a great price too.** See inside for more details.

## 10,000,000 Candle Power Rechargeable Halogen Spotlight

NEW

10,000,000 Candle Power! This amazing Halogen Spotlight features a super powerful Philips H4 Quartz halogen globe, swivel stands for various mounting positions, rocker power switches for hands-free use, all in a high-impact ABS plastic, weatherproof body. A switch for dim lighting is also included in order to conserve power when high-brightness is not required. The internal 12V 7Ah SLA batteries can be charged through your car's cigarette lighter, or the supplied plug pack. Perfect for boating or recreational use. This light will be seen for kilometres!

•Lens diameter: 175mm •Supplied mains & in-car charger

Cat. ST-3306 $99.95

## Replacement Power Supply for Masthead Amps and Splitters

The power supply for a masthead amplifier or splitter is unique and cannot be replaced by a standard unit. These supplies have a PAL injector to suit many masthead amplifiers and splitters.

PSU For Masthead Amps
17VAC @ 100mA - Cat. LT-3296

PSU For Masthead Amps/Splitters
14VAC @ 150mA - Cat. LT-3298

NEW

Both Types (ea) $23.95

## Wireless Stereo FM Transmitter for Cars

Use your CD/MD/PDA/MP3 player to listen to your favourite tunes through your car's FM radio. The transmitter broadcasts quality sound quickly and easily. Simply attach to your portable audio player and tune your car stereo to the appropriate frequency range.

NEW

Cat. AR-3110 $34.95

## Wrist Watch with Digital Camera, PDA & Games

NEW

With all the standard features of a regular digital watch, it also has a personal organiser, and even a 20k pixel mini digital camera. Unlike many wrist watch cameras, the watch face acts as a screen, to check what you are about to photograph, taking out the normally associated guess work. The internal memory can store up to 44 images in low resolution, or 11 images in high resolution. The personal organiser features include calendar, schedule, 'to do' list, phone book, and even games! It is supplied with a serial data interface for downloading images and updating the PDA from your PC. An amazing, feature packed unit. See our website for full features and specifications.

Cat. QC-3384 $129.95

**NEW STORE IN CARINGBAH - OPENS LATE JANUARY**
**49A Captain Cook Drive. Caringbah. NSW. 2229.**

## Melcom 8 Sector Alarm Panel with Built-In Dialler

NEW

A fantastic new panel from Melcom, with a host of features and a telephone dialler. It allows up to 12 arm/disarm codes, programmable for partial or complete disarming. Up to 6 keypads can be used, it can be programmed via a PC (with optional software and cable), and has provisions for an optional relay board which allows 6 switched outputs which can be operated via the keypad or touch tone telephone. See our website for a full list of great features and specifications.

AVAILABLE NOW

Cat. LA-5425 $449.00

## Melcom 8 Sector Alarm Kit with Dialler

Compare the price of this full kit against others on the market with similar features, and you will be impressed. Do it yourself & save a fortune!

**Install an alarm at home while you can!**

Kit Includes:
- 1 x Melcom 8 Sector Panel with Dialler
- 1 x LCD Keypad 3 x Proton Quad PIR's
- 1 x 7Ah Back Up Battery
- 1 x Plug Pack 3 Wire Power Supply
- 1 x Strobe Light
- 1 x Indoor Siren
- 2 x Reed/Magnet Assemblies
- 1 x Siren Cover/Outdoor Siren Speaker
- 100m Roll 6 Core Austel Approved Cable
- 1 x 30m Roll 2 Core Cable
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NEW

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Cat. LA-5426 $749.00

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## Rechargeable Electronic Candles

NEW

Seen through the frosted glass shade, these electronic candles are almost impossible to distinguish from ordinary tea-lights. They are however much safer and can be left unattended without the worry of anything being burnt if knocked over.

A Li-Ion battery fitted to the candle will provide up to 10 hours of continuous operation and the optional frosted candle holders will further enhance the effect.

Cat. ST-3922 **$29.95**

### Candle with Charger

- Spare Candle Cat ST-3920 $14.95
- Glass Frosted Shade Cat ST-3923 $5.50
- Glass Frosted Shade Metal Trim Cat ST-3924 $5.95

## Aromatherapy Table Lamp

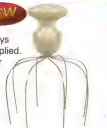
Never runs out of candles! Normally aromatherapy fragrances are heated with a candle which can be messy, inconvenient, and possibly dangerous. This fully approved unit features a small 240V (25 Watt) lamp. The lamp not only heats the oil but is a small attractive unit in itself. When not producing aromas, it can operate as a small table or bedside lamp. Supplied with 3 fragrances, Lavender, Lemongrass, and Sandalwood. Measures 115 x 115 x 110mm

NEW

Cat. GH-1045 **$39.95**

## Vibrating Head & Joint Massager

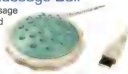
NEW



Just the thing for relief after a hard days work. There are two attachments supplied. One has little knobs to provide all over relief, the other has 8 shaped rods to massage a large portion of your head at one time. Requires 2 x AA batteries.

Cat. GG-2260 **$19.95**

## USB Powered Massage Ball

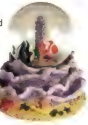


This handy, palm size massage pad fits snugly in your hand and has a knobby surface that acts like a thousand fingers to loosen tense muscles and tired limbs. Powered from your USB port, it's ideal for giving yourself a quick massage whenever you need it.

Cat. GG-2265 **$24.95**

NEW

## Aqua Domes



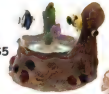
Realistic looking fish swim around and around due to a rotating magnetic field. The movement is very lifelike! To further enhance the kitsch, they have falling snow when inverted! Cool!

- Require batteries.

### 120mm Dia. Dome

**Was $34.95 Save $5**

Cat. GH-1210 **$29.95**



### 150mm Dia. Dome

**Was $49.95 Save $5**

Cat. GH-1212 **$44.95**

## Electronic Toy Safe

Store your valuable possessions such as, jewellery, money, and keys with this compact electronic safe. Access is controlled by a programmable code. Selectable sound effects or synthesized voice. Requires 3 x AA batteries. Measures 185 x 135 x 125mm. Two colours available:

- Pink Safe Cat GH-1310
- Blue Safe Cat GH-1311

NEW

Both Models **$19.95 ea**

## Self Frothing Coffee Mug

NEW

Just pour in a little milk, press the button and "hey-presto", frothy milk in a flash. The perfect base for an instant cappuccino. Can also be used to stir-in milk & sugar in ordinary tea and coffee. Requires 2 x AA batteries.

Cat. GH-1300 **$19.95**

## Novelty Farting Man

NEW

Endless fun for all jokers old enough to understand. This animated man turns his head, drops his pants and lets off a series of rip-roaring farts when someone passes by. Uses 3 x AA batteries, included.

Cat. GT-3100 **$24.95**

## Electric Plastic Bag Sealer

NEW

Want to keep food items fresh? Want to protect important documents? The Handy Sealer will do the trick! In 3 seconds, the battery operated sealer heats up and seals plastic. Measures 45 x 95 x 40mm. Requires 2 x AA batteries.

Cat. GH-1320 **$12.95**

## Novelty Desktop Mini Golf

Challenge your friends and see who can sink that chip or putt. Supplied with a miniature action golfer to sink that ball. See website for details.

NEW

Cat. GT-3150 **$9.95**

## 12V Electric Blanket

NEW

Keep warm on long distance car trips with this versatile 12V electric blanket. Made from 100% Terylene fabric, it contains a safe, low voltage heating element. Supplied with a 2.5m lead and cigarette lighter plug.

- Measures 1.5m x 1.1m.

Cat. GH-1205 **$49.95**

## Miniature Radio Controlled Battle Tanks with Sounds

Table-top tank battles have now become even more exciting with these new remote controlled replica tanks. They feature a rotating turret with realistic recoil action and cannon sound when the cannon is fired. The tanks are supplied with miniature battlefield soldiers, trees, and fuel drums to complete your mini table-top war zone. Get two tanks and engage your opponent in a one-on-one tank battle. Each is supplied with its own individual remote controller.

NEW

Two types available:

Panther Tank in Jungle Camouflage Cat. GT-3046
Sherman Tank in Desert Camouflage Cat. GT-3048

Both Types (ea) **$44.95**

DUE LATE JANUARY

## 8 Litre Collapsible Bucket

This great 8 litre bucket collapses down to pack away, so it's ideal for camping, hiking or any situation where storage space is an issue. Supplied with a great carry pouch. Measures 255 x 35mm when folded, 255 x 230 when open.

NEW

Cat. GH-1260 **$14.95**

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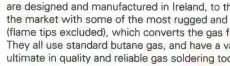
www.jaycar.com.au

# **Portasol** Gas Soldering Tools

Jaycar is serious about quality, and soldering products are no exception. We have searched the globe for reliable gas powered soldering products, and the result is what you see on this page. A leading brand recognised worldwide, their quality is second to none. Portasol products are designed and manufactured in Ireland, to the highest quality standards. Since commencing operation in 1983, they have forged their way into the market with some of the most rugged and reliable gas powered soldering and heating tools in the world. They utilise catalytic combustion (flame tips excluded), which converts the gas flame into infrared radiation. It is a safe, flameless way of heating the tips evenly and continuously. They all use standard butane gas, and have a variety of tips available (see website for details) to support a wide range of applications. For the ultimate in quality and reliable gas soldering tools, you can't go past Portasol.

## 50 Gas Soldering Iron



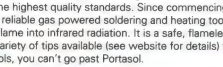

The Portasol 50 is designed specifically with the dedicated DIY enthusiasts in mind. Powered with standard butane gas, it has a run time of around 30 minutes. Ignition is via the flint ignitor in the cap, and tip temperature reaches an impressive 350ºC. It is fixed temperature, with equivalent electrical power of around 35W. It features automatic shut-off when the end cap is replaced and fast refill time. It is a quality tool, sure to give you many years of trouble free operation.

Specifications:

- Operating Time: 30 min (approx).
- Refill Time: 10 sec (approx).
- Ignition: Flint ignitor in end cap.
- Dimensions: 196(L) x 26(W) x 19(D)mm.
- Weight: 60g without gas.

Cat. TS-1300 $39.95

## Technic Gas Soldering Iron




The Portasol Technic combines compact power, and convenient reliability, making it one of the most versatile gas soldering irons available. It offers a run time of around 60 minutes, and tip temperature is adjustable up to 450ºC. With equivalent electrical power of between 10 and 60 Watts, it is ready to tackle just about anything. The protective end cap features a built in flint type ignitor, and if the gas is left on, it will turn it off when replaced. If a compact, versatile, and reliable gas iron is what you're after, then the Portasol Technic is for you.

Specifications:

- Operating Time: 60 min (approx).
- Refill Time: 10 sec (approx).
- Ignition: Flint ignitor in end cap.
- Dimensions: 170(L) x 19(Dia)mm.
- Weight: 60g without gas.

Cat. TS-1305 $59.95

## Gas Powered Glue Gun

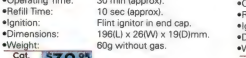
A quality, butane powered hot glue gun that can be used almost anywhere. The gun features easy push button piezo electric ignition so you don't have to fumble with matches, and a translucent fuel tank that lets you see how much gas is left. The glue will bond to most household materials including ceramics, metal, fabric, leather, wood, and plastics. Uses standard glue sticks available everywhere.

Specifications:

- Operating Time: 2 Hrs (approx).
- Heat Up Time: 3 min (approx).
- Ignition: Internal Piezo crystal ignitor.
- Weight: 200g without gas.

Cat. TH-1330 $69.95

## Pro Piezo Gas Soldering Iron



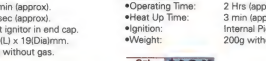

The Portasol Pro Piezo is a powerful gas soldering iron, featuring an adjustable temperature control allowing soldering tip temperatures up to 580ºC. With equivalent electrical power of between 15 and 75 Watts, there is little that's not possible this beauty. It incorporates a viewing window at the end of the gas tank, to keep an eye on the fuel level. The fuel tank fills in around 20 seconds, and will provide approximately 45 minutes of run time. Ignition is via the built in Piezo crystal mechanism, and the end cap provides safety gas shut off when replaced. The Portasol Pro Piezo is a dream to use, and will not let you down. Supplied with a 2.4mm double flat tip.

Specifications:

- Operating Time: 45 min (approx).
- Refill Time: 20 sec (approx).
- Ignition: Internal Piezo crystal ignitor.
- Dimensions: 178(L) x 22(Dia)mm.
- Weight: 75g without gas.

Cat. TS-1310 $89.95

## Super Pro Gas Soldering Iron




The Portasol Super Pro is the big brother of all irons in the range. It features adjustable tip temperature up to 580ºC, with equivalent electrical power of between 25 and 125W! 125W may seem somewhat excessive to some. You don't need a V8 to drive around town, but it's nice to know that the power is there when it's needed, isn't it? Ignition is achieved with the internal Piezo crystal mechanism, and run time is around 2 hours on a 30 second refill. The stainless steel finished gas tank features a viewing window to keep an eye on fuel level, and the protective end cap also acts as a safety cut off for the gas valve control when replaced. With the various tips available and huge power at hand, no job is a match for the Portasol Super Pro.

Specifications:

- Operating Time: 120 min (approx).
- Refill Time: 30 sec (approx).
- Ignition: Internal Piezo crystal ignitor.
- Dimensions: 234(L) x 25(Dia)mm.
- Weight: 135g without gas.

Cat. TS-1320 $109.00

## **Portasol** Pro Piezo Gas Soldering Tool Kit

This kit contains a Portasol Pro Piezo Gas Soldering Iron, and all of the following parts.

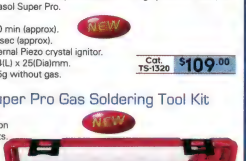
- Quality storage case.
- Cleaning sponge and tray.
- 2.4mm double flat tip (TS-1312).
- Hot air blow (TS-1314).
- Hot knife tip (TS-1315).
- Hot air deflector.
- Flame tip (TS-1316).

Cat. TS-1318 $119.00

## **Portasol** Super Pro Gas Soldering Tool Kit

This kit contains a Portasol Super Pro Gas Soldering Iron and all of the following parts.

- Quality storage case.
- Cleaning sponge and tray.
- 2.4mm double flat tip (TS-1322).
- 4.8mm double flat tip (TS-1323).
- Hot air blow (TS-1324).
- Hot knife tip (TS-1325).
- Hot air deflector.



Cat. TS-1328 $149.00

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OVER 5,500 PRODUCTS IN STORE
JAYCAR ELECTRONICS

# Exciting New Science Experimenters Kits

**Jaycar is proud to announce the addition of well developed and highly advanced scientific learning kits for High School, Technical Institution, and University Students.**

**They are not like those low cost Chemistry set-type kits you see in toy stores. They are of superior quality with superior documentation written by academics. The various kits cover many areas of science and discovery. While they are sophisticated and very educational, they are still a huge amount of fun. Each kit is supplied with everything necessary to complete the projects outlined in the instruction manual, and any safety equipment required (eg. safety goggles). See our website for full details, or drop into your local store for more information.**

## Operating Fuel Cell Powered Car with Multiple Experiments

NEW

This technically superb product contains an actual working pressure vessel fuel cell. The kit enables you to learn how fuel cells actually work by building and operating a small car that is powered by the fuel cell. You are provided with the equipment to make the Oxygen and Hydrogen fuel (by electrolysis) and then burn it in the fuel cell to make electricity. The package comes with a magnificently illustrated 90-page+ text with suggestions for 30 experiments. The book also gives background information and a full explanation of fuel cell mechanics. All theory is covered, not sidestepped.
The kit also comes with a sophisticated digital multimeter (needed for the experimental work) a 130mm x 120mm solar panel, electric motor, axles, car chassis, wheels, etc. This kit is NOT a toy - more a formal learning instrument than a kit for home consumption. *Distilled water is required.

Cat. KT-2500 $299.00

**CONTAINS AN ACTUAL FUEL CELL!**

## Alternative Energy Model House with Experiments

NEW

This product enables students of alternative energy sources to experiment in a realistic way. The kit focuses on sources of heat and light from the sun to operate a small model house. Energy from wind, electromechanical and plant energy sources are also investigated.
Kit contains materials to make (among other things), a sun furnace, heat trap (greenhouse), energy converters, windmill generator, solar cooler, water desalinator, electric generator, etc. A 96-page manual written by physicist Uwe Wandrey guides you all the way. The lessons learnt from this may inspire people to scale up the physics to a full size house. More a formal learning instrument than a kit for home consumption.

Cat. KT-2502 $299.00

## Crystal Pro - Crystal Growing and Crystallography Kit

NEW

Crystals have fascinated and enchanted people since ancient times. This kit teaches all about the composition of crystals by growing your own large, beautiful crystals with complex shapes and fantastic colours. The kit contains materials for growing crystals and associated equipment to complete the 14 different experiments.

THERE ARE 14 EXPERIMENTS DESCRIBED IN THE 32 PAGE MANUAL.

Cat. KT-2518 $59.95

## Detector Radio - Electromagnetic Radio

NEW

Based on the principal of early crystal radios, it uses electromagnetic power functioning without power from mains or batteries. Learn about HF coils, capacitors, resistors, and diodes. Discover how antennae work, and challenge yourself to pick up transmissions from far away. The kit contains all materials to assemble and complete the experiments.

THERE ARE 20 EXPERIMENTS DESCRIBED IN THE 32 PAGE MANUAL.

Cat. KT-2508 $59.95

OVER 5,500 PRODUCTS IN STORE

## Micro TREK - Journey into Microspace

NEW

Using a 100x - 900x microscope, Micro TREK takes you on a journey through the microscopic world. Discover hidden creatures and normally unseen structures, and learn how to use a microscope and about each of its parts. Examine prepared slides, and also gather specimens yourself. It includes a projector attachment to trace images and record them with film. Discover how microscopes have played a crucial role in the development of the natural sciences, and continues to do so. The kit is supplied with high quality die-cast metal microscope, projector and photography attachment, prepared and blank slides, and much more. **The 52 page manual** guides young microbiologists, aspiring chemists, and microscope hobbyists through setup, usage and dozens of fascinating observations.

Cat. KT-2520 **$169.95**

## Minds Eye - Optical Illusions and Human Perception

NEW

Astonish yourself with optical illusions as you explore the science of human perception. Find a blind spot within your eye, and watch things disappear. Make a curved line look straight, turn cardboard transparent, see the world shrink, and much more. You will learn how your eyes and brain work together to perceive colour, light, depth, perspective and more.

The kit is supplied with all parts required to complete the 94 experiments including rotating disk, prisms, solar cell, lenses, coloured films, and much more.

THERE ARE OVER 94 EXPERIMENTS CONTAINED IN THE HUGE 100 PAGE MANUAL.

Cat. KT-2504 **$149.00**

## CHEM C1000 - Chemistry Experiment Kit

NEW

Begin building a strong foundation in chemistry with exposure to a broad range of chemical phenomena and hands on laboratory experience. Make water flow uphill using air pressure, entertain your friends with chemistry 'magic tricks', and much more. Professional quality equipment and thorough safety precautions helps you make the most out of your chemistry experiments.

THERE ARE 75 EXPERIMENTS, ALL COVERED IN THE 40 PAGE INSTRUCTION MANUAL.

Cat. KT-2516 **$149.95**

## Kite Dynamics - Kite Building and Experiment Kit

NEW

Soar to new heights with a kite you design and build yourself! A unique connector system allows almost limitless design possibilities. In addition to the large practical content, the manual covers the theory, physics, and history of kites. You will learn about lift, drag, Bernoulli's principle, how to calculate a kite's height, and how to determine the air temperature at that height. All parts are included to build a kite.

THERE ARE 9 EXPERIMENTS, ALL COVERED IN THE 32 PAGE MANUAL.

Cat. KT-2514 **$99.95**

## Solaro - Solar Powered Models

NEW

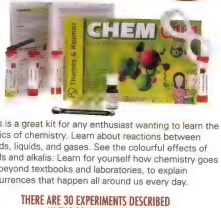
Harness the power of the sun to power up seven models of real world vehicles and devices. The models are made from polystyrene parts, and can be fitted with the supplied solar cells and motor, to help demonstrate the real world applications of solar power. The manual explains just how much power the sun has to offer, current applications of solar power, how solar cells produce electricity, and much more.

THERE ARE 7 MODELS WITH INSTRUCTIONS IN THE 32 PAGE MANUAL.

Cat. KT-2522 **$99.95**

## CHEM C101- Introduction to Chemistry

NEW




This is a great kit for any enthusiast wanting to learn the basics of chemistry. Learn about reactions between solids, liquids, and gases. See the colourful effects of acids and alkalis. Learn for yourself how chemistry goes far beyond textbooks and laboratories, to explain occurrences that happen all around us every day.

THERE ARE 30 EXPERIMENTS DESCRIBED IN THE 32 PAGE MANUAL.

Cat. KT-2510 **$59.95**

## Bubble Builder - The Wonderful World of Bubbles

NEW

Since ancient times, people have been fascinated by the unique properties of soap bubbles. You will learn how to mix the best bubble solution, blow giant bubbles, mini bubbles, bubbles within bubbles, chains of bubbles and more. Build soap film domes, roofs, and bridges.

THERE ARE 35 EXPERIMENTS DESCRIBED IN THE 32 PAGE MANUAL.

Cat. KT-2512 **$59.95**

## Balloon Adventure - Scientific Explorations with Balloons

NEW

Take a balloon adventure through topics in physics, chemistry, and biology. Race balloon powered cars, fly a balloon helicopter and puncture a balloon without popping it. Learn how to measure your lung capacity, build a fire extinguisher, even a water yo-yo.

THERE ARE 24 EXPERIMENTS DESCRIBED IN THE 32 PAGE MANUAL.

Cat. KT-2506 **$59.95**

OVER 5,500 PRODUCTS IN-STORE
JAYCAR ELECTRONICS

## 7" TFT LCD Widescreen* Colour Monitor with Infrared Remote

In-car and home entertainment system ideal for watching DVD's, PS2, XBOX etc.
- On screen display for all controls.
- Includes a slim and stylish remote control.
- Extremely high picture quality & stable performance
- Mirror image function
- 7" Widescreen TFT (thin film transistor) Active Matrix System for optimum performance.
- On screen display for all controls

***Will work with most, but not all widescreen sources. Will default to modified widescreen in some cases.**

SAVE $100

Cat. QH-3752 **$399** **WAS $499**

## New Surveillance Cameras

Great new additions to our range. See website for details.

**Colour CCD Pinhole Camera**
Cat. QC-3493 **$259.00** NEW

**Dome Style Colour CCD Camera with Panasonic Sensor**
Cat. QC-3498 **$369.00** NEW

**Pro Style 420 Line Colour CCD camera with Auto-Iris Controller and Audio**
Cat. QC-3314 **$249.00** NEW

## Rechargeable 12V LED Torch

Keep this great portable LED torch in your car, caravan or boat, it plugs into a 12V cigarette lighter socket to recharge. It features an focusing lens for maximum brightness, and a blue LED to indicate charge status.
See website for details.

NEW

Cat. ST-3360 **$24.95**

## Fast Charger and Ni-MH Battery Combo

A great 240VAC fast charger, and 4 x AA 1650mAh Ni-MH batteries.

Save $4.80 off individual parts prices!

Cat. MB-3532 **$29.95** NEW

## SurfCam USB Web Camera

Ideal for video conferencing and general home use. Supplied with editing software.

SAVE $15 **WAS $49.95**

Cat. QC-3220 **$34.95**

## Ioniser Pet Brush

Revitalise your pet's hair in minutes. The ion generator in the brush releases electrically charged particles helping to precipitate dirt, pollutants, and odours. Requires 2 x AA batteries.

Cat. QH-1200 **$19.95**

## Binoculars with a Mini Digital Camera

SAVE $30

This great unit combines a 300k pixel digital camera, with 8x zoom binoculars! That means that you can capture clear, crisp images from a distance. As well as taking great photo's, it can also store up to 100 seconds of video. Supplied with a handy belt pouch for protection.
- Max resolution 300k (640 x 480) pixel.
- Uses 2 x AAA batteries, included.
- Measures 110 x 90 x 46mm.

**WAS $129.95**
Cat. QC-3198 **$99.95**

## 1.8 Amp 6/12V Sealed Lead Acid Battery Charger

NEW

Keep your 6V and 12V SLA batteries fully charged. When the battery is fully charged, the unit switches to trickle charge. Supplied with a 2.1mm DC plug and a lead with battery clips. See website for details.

Cat. MB-3523 **$49.95**

## Keyring Screwdrivers

- Contains a 5mm slotted, and #2 Phillips driver.
- Just 55mm long (ea).

Cat. TD-2012 **$2.95**

## 5 in 1 Folding Multi Tool with Torch

NEW

- Pliers, wire cutter, saw, bottle opener, knife, Phillips, and slotted drivers.

Cat. TH-1906 **$14.95**

## Electroluminescent (EL) Wirelight

This amazing wire light glows when power is applied. It will add a new dimension to interior lighting in your car, or create effects around your stereo or computer. The uses are endless! Two styles are available.

### 12VDC Version

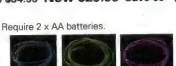
Pre wired with a 1.2m lead and 1m EL wire.
- White Cat. SL-2835
- Red Cat. SL-2836
- Blue Cat. SL-2837
- Green Cat. SL-2838
- Orange Cat. SL-2839

**All colours (ea) Were $34.95 Now $29.95 Save $5**

### Hand Held Version

Pre wired hand controller. Require 2 x AA batteries.

- Aqua Cat. SL-2845
- Lime Cat. SL-2846
- Red Cat. SL-2847
- Blue Cat. SL-2848
- Orange Cat. SL-2849



**All colours (ea) Were $24.95 Now $19.95 Save $5**

## The Amazing Flygun

The Amazing Flygun is a spring powered gun that kills flies and mosquitos! It is fun, safe, and easy to use. You can become a hunter in your own home! Simply push the swatter onto the gun and you are ready to swat flies. A 1 metre long string is attached so the swatter doesn't get lost, you can then reload, aim and fire again. Its fun and effective, and really does work!

**Was $9.95 Save $2**

Cat. YS-5545 **$7.95**

## Hung Chang 20MHz Dual Channel, 4 Trace Oscilloscope

A great dual channel oscilloscope designed for the professional and enthusiast alike. Housed in a pressed steel cabinet with heavy duty feet and comprehensive control panel, it is a great, high quality unit. It features a large 6" screen, zero parallax graticule to eliminate reading errors, TV sync for stable synching of video signals, and high sensitivity input amplifiers for measurement down to 1mV/div. See our website for a huge list of features and specifications.

NEW

Cat. QC-1908 **$799**

## Programmable Digital LCD Soldering Station

Save $60

Was $199

Cat. TS-1400 **$139**

This great iron features excellent temperature stability, rapid heat recovery, 3 programmable preset temperatures, and temperature adjustment between 150°C and 450°C. See website for details.

**During January, purchase a Programmable Digital LCD Soldering Station & we will give you a Soldering Iron Tip Cleaner (TS-1510 $12.95) and a Deluxe Antistatic Desoldering Tool (TR-1865 $29.95) FREE! That's an additional $42.90 value ABSOLUTELY FREE! A total saving of over $100!**

## Automotive OBDII Diagnostic Plug

NEW

Used in automotive diagnostic applications. Refer to December Silicon Chip Magazine for more information.

Cat. PP-0720 **$29.95**

## Soldering Iron Tip Cleaner/Tinner

goot

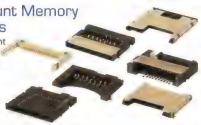
The Goot tip cleaner/tinner revitalises and restores tips so there almost as good as new. It contains solder powder, and non corrosive flux, so it cleans and tins your tip at the same time. Supplied in a 15g tin, it also has double sided tape, so you can stick the tin to your work bench or soldering station

NEW

Cat. TS-1512 **$6.50**

## Surface Mount Memory Card Sockets

Ideal for development and hobbyist applications, or even repairing existing units. See our website for full data sheets.



| | | |
|---|---|---|
| **Multimedia Card** | **Cat. PS-0020** | **$3.95** |
| **Memory Stick** | **Cat. PS-0022** | **$3.95** |
| **Secure Digital** | **Cat. PS-0024** | **$3.95** |
| **XD Card** | **Cat. PS-0026** | **$4.95** |
| **Smart Media** | **Cat. PS-0028** | **$4.95** |
| **Compact Flash** | **Cat. PS-0030** | **$5.95** |
| **4 in 1 – MMC, SD, Memory Stick, Smart Media** | **Cat. PS-0032** | **$14.95** |

## Replace Your Incandescent Lamps with LED Style Globes!

NEW

LEDs are much more efficient, and less fragile than filament globes. LEDs mounted on standard Bayonet, Miniature Edison Screw (MES), and MR16 Halogen bases provide excellent replacements in many applications, consuming less power and lasting much longer. See our website for individual details.

| | | |
|---|---|---|
| **3 x White LEDs on Bayonet base - 4.5V** | **Cat. ZD-0310** | **$9.95** |
| **6 x White LEDs on MES base - 6V.** | **Cat. ZD-0300** | **$19.95** |
| **6 x White LEDs on Bayonet base - 12V.** | **Cat. ZD-0302** | **$21.95** |
| **12 x White LEDs on MES base - 6V.** | **Cat. ZD-0304** | **$21.95** |
| **12 x White LEDs on Bayonet base - 12V.** | **Cat. ZD-0306** | **$27.95** |
| **12 x White LEDs on MR16 (Halogen Type) base 12V** | **Cat. ZD-0315** | **$29.95** |
| **12 x Red LEDs for Car Tail Lamp - 12V** | **Cat. ZD-0312** | **$18.95** |
| **12 x Amber LEDs for Car Indicators - 12V** | **Cat. ZD-0314** | **$19.95** |

## 3.6V Cordless Screwdriver with Pivoting Handle

NEW

Nothing beats the convenience of a cordless screwdriver when you have numerous screws to install or remove from a job. It features a powerful motor, forward & reverse switch, safety power lock, 6 torque settings and reversible Phillips/Flat driver bit. See website for details.

Cat. TD-2495 **$19.95**

## DURATECH 40 Watt Soldering Iron

Ideal for the hobbyist and handy person. It has a stainless steel barrel, and strong impact resistant handle. Fully electrically safety approved. See our website for the entire range!

Cat. TS-1475 **$27.95**

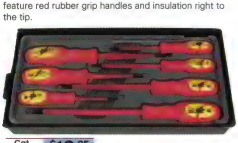
## Soldering Kit

Great starter pack! Includes a 25W Duratech soldering iron, quality stand and sponge, solder, and a desolder wick.

Cat. TS-1650 **$31.95**

## 1000V - 7 Piece Screwdriver Set

GS and DVE tested and approved to 1000V. They feature red rubber grip handles and insulation right to the tip.



Cat. TD-2022 **$19.95**

## 1Kg Solder Roll 60% Tin/40% Lead

DURATECH

Two sizes available, 0.71mm and 1mm diameters. 0.71mm is ideal for fine work with IC's and all fine soldering. 1.00mm is better for terminals, cable, and larger jobs. Both are resin cored. 0.71mm Cat NS-3002 1.0mm Cat NS-3015

Save $5

Both Types (ea) **$28.95**

## Butane Gas

Suitable for any of our gas powered soldering irons, torches, and glue guns. Includes 5 different adaptors which cover most different nozzles. 150g can. Mail order customers - aerosols must be sent by road freight only.

Cat. NA-1020 **$5.95**

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www.jaycar.com.au

Jaycar ELECTRONICS

# LEARNING ELECTRONICS IS FUN!

## Sound Like a Dalek

This project will change your voice into that metallic sounding robot so familiar in space adventure movies. PCB and parts supplied. Connect it to the 'No Brainer' amp and get really scary!

Cat. KJ-8228 $19.95

## "No Brainer" Amplifier

This amp is so easy to build, it's a no brainer! It will, however, give a powerful output to bring your Discman, sound card, etc. alive! Speaker supplied. Two required for stereo. PCB and relevant parts included.

Cat. KJ-8216 $12.95

**This is just a sample of over 20 kits available in the Short Circuits 2 range. See our website for all available kits.**

## Short Circuits Volume 2

Once you have the basic skills and knowledge either from a School Design and Technology course, or tackling Short Circuits Volume 1, you can now have some real fun! With this book (and the associated project packs – see below), you can make such things as; a mini strobe light, police siren, mini organ, a couple of powerful radio transmitters, an FM radio, even a 'Knight Rider' scanner! All components are fully described and explained, along with tutorials on soldering iron and multimeter use. All projects are safe and powered by a 9V battery. See website for full details on the Short Circuits Learning Systems and individual projects.

## Short Circuits 2 Project Book

Soft cover, full colour, 205 x 275mm.

Cat. BJ-8504 $14.25

## Jiminy! What's That Cricket Noise?

This fun project makes the distinct sound of a cricket when triggered by a hidden microphone. Someone walks into the room, says something, and next thing this loud cricket starts to chirp! Hours of fun. PCB and all other parts including microphone supplied.

Cat. KJ-8224 $12.95

## Countdown Timer

This neat project enables you to dial a time you want to elapse before you want something to happen, say the exposure of a camera shutter, or an electrically operated door to stay open. At the end of the timed period (seconds to many minutes) a relay is energized which can switch something on or off. PCB and all parts supplied, including relay.

Cat. KJ-8202 $12.95

## Casino! Electronic Dice

At the press of a button "roll", 6 light emitting diodes flash briefly, and only one stays lit, representing a number between 1 and 6. Truly, truly random and never runs off the table. PCB and all parts supplied.

Cat. KJ-8222 $12.95

## FM Radio with Electronic Tuning

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**This simple adaptor allows commonly available electret lapel and headset microphones to be used with public address systems. It features a balanced output and is built into a compact case that can be clipped to a belt or slipped into a pocket.**

***By JOHN CLARKE***

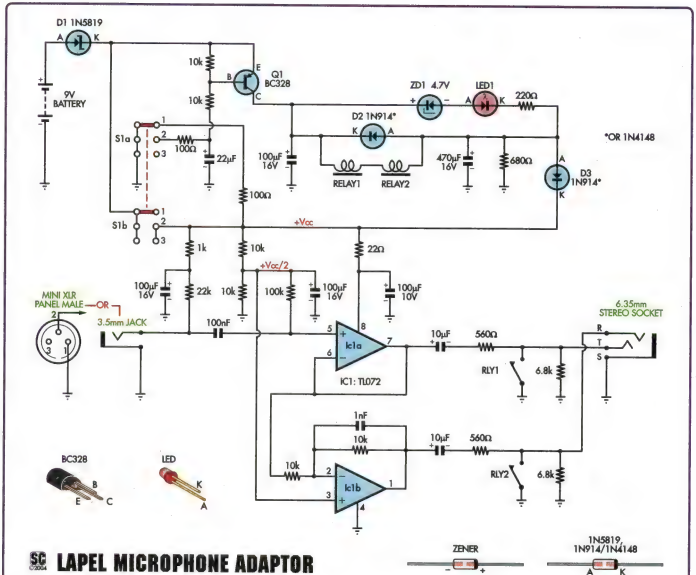
# Lapel microphone adaptor for PA systems

WHILE STANDARD HANDHELD microphones are generally used for most public address (PA) applications, there are times when a lapel microphone is much more convenient. A lapel microphone not only frees up a user's hands but also allows the wearer to roam about easily. They are ideal when giving talks and lectures, and for certain types of theatre work.

Another advantage of lapel microphones is that they provide a reasonably consistent output, even when the person speaking turns their head. That's because a lapel microphone is usually clipped to the user's clothing around the chest area and so remains at a similar distance from the mouth regardless of head movement. By contrast, hand-held microphones must always be held close to the mouth, otherwise the signal level will vary drastically.

Lapel microphones are generally available in two forms. By far the most common form for PA use at the present time is the radio microphone. This consists of the lapel microphone itself plus a small radio transmitter which is worn by the user – eg, inside a shirt pocket or by attaching it to a belt. The signals from the transmitter are picked up by a corresponding receiver which then feeds the signal to the PA system.

The big advantage of the radio




# LAPEL MICROPHONE ADAPTOR

**Fig.1: the circuit uses op amps IC1a & IC1b to provide a balanced output signal, while relays RLY1 & RLY2 shunt the signal to ground when activated, to provide muting.**

microphone is that it allows the user to roam freely over several tens of metres without being tethered to a lead. However, this freedom comes at a high cost, with complete radio microphone systems typically costing around $600.

Despite its advantages, this high cost cannot always justified, especially when full use of the radio transmitting feature is not exploited. This particularly applies to applications where the user doesn't need to roam too far. In those situations, a much cheaper solution is to dispense with the radio system and instead use a tethered lapel microphone – ie, one that's tethered to the PA amplifier via a lead.

However, obtaining such a wired lapel system is quite another matter. Music shops are keen to sell the wireless microphones but are usually at a loss when asked to supply a wired type. The older-style dynamic lapel microphones simply no longer appear to be available, while the smaller electret microphones require a power source.

So why can't you simply use an electret microphone and power it from the phantom supply that's sometimes available in PA mixers? Unfortunately, it's not as simple as that, for a couple of reasons.

First, many mixers do not have phantom power and if they do, the current available is well in excess of that required for an electret microphone. Electrets require only 0.5mA or less for correct operation, whereas

## Main Features

- Uses standard electret lapel microphone
- Adaptor attached to belt or in pocket
- Battery powered (9V)
- Balanced output
- Muting facility
- Battery indicator

## Parts List

1 PC board, code 01101041 (86 x 64mm) for Jaycar and DSE cases; or code 01101042 (81 x 61mm) for Altronics case
1 case measuring 135 x 70 x 24mm with battery compartment (DSE Cat. H 2949 (grey), Jaycar Cat. HB 6510 (black), Altronics H 0342 (grey))
2 panel labels, 59 x 16mm and 114 x 50mm
1 belt/pocket clip (Farnell 353 6294 (grey) or 353 6282 (black))
1 lapel microphone (Jaycar AM-4092 or Altronics C 8907 or C 8913)
2 5V reed relays (RLY1, RLY2) (Jaycar SY 4036)
1 double-pole 3-position (DP3W) slide switch (S1) with 2 x M2.6 mounting screws (Altronics S 2030)
1 3.5mm PC board socket (Jaycar PS 0133) or 3-pin chassis male miniature XLR connector (Altronics P 0891) – see text
1 right angle stereo 6.35mm jack plug to 3-pin XLR line plug lead (Altronics P 0902 XLR line plug and P 0047 jack)
5 metres of dual-screened microphone cable (Altronics W 3028)
1 stereo 6.35mm metal line socket (Altronics P 0080A, Jaycar PS 0194))
1 9V battery clip lead
1 9V battery
3 M3 x 6mm screws
1 M3 x 10mm countersunk screw
1 M3 x 20mm countersunk screw
1 M3 x 10mm tapped spacer
1 50mm cable tie
13 PC stakes

**Semiconductors**

1 TL072 dual op amp (IC1)
1 BC328 PNP transistor (Q1)
1 4.7V 1W zener diode (ZD1)
1 1N5819 Schottky diode (D1)
2 1N4148, 1N914 diodes (D2,D3)
1 3mm green LED (LED1)

**Capacitors**

1 470µF 16V PC electrolytic
4 100µF 16V PC electrolytic
1 22µF 16V PC electrolytic
2 10µF 16V PC electrolytic
1 100nF MKT polyester
1 1nF MKT polyester

**Resistors** (1% 0.25W)

| | |
|---|---|
| 1 100kΩ | 1 680Ω |
| 1 22kΩ | 2 560Ω |
| 6 10kΩ | 1 220Ω |
| 2 6.8kΩ | 2 100Ω |
| 1 1kΩ | 1 22Ω |

the phantom power from a PA mixer is usually between 14mA and 60mA – enough to destroy an electret unless precautions are taken.

Second, an electret microphone provides only a single "unbalanced" output. This means that there are just two output connections – ie, the shield and the signal wire. However, any leads that are several metres long or more in a PA system can readily pick up 50Hz mains frequency hum which is then amplified and fed through to the loudspeakers as an annoying buzz.

### Balanced output

The way around this problem is to use what's known as a "balanced" output. This type of output has two signal outputs plus a shield lead, with one output inverted with respect to the other.

In this case, both signal leads still pick up mains frequency hum but because the lines are balanced, the hum signal can be rejected to just leave the wanted microphone signal. This is done in the PA mixer – it receives the balanced signal and subtracts the non-inverted microphone signal from the inverted microphone signal. This removes the mains hum signal, since the same signal will be present in both leads. By contrast, the microphone signal is doubled, since subtracting an inverted signal from the non-inverted signal gives twice the signal level.

## Specifications

**Frequency response:** 16Hz to 16kHz (actual response depends on the microphone used)

**Output level:** typically 100mV

**Current consumption:** 4mA when on, 11mA on mute, 0.1µA when off

### Lapel microphone adapter

That's where the Lapel Microphone adapter comes in – it not only provides power to a standard electret microphone but also includes all the necessary circuitry to provide balanced output signals. In addition, it also includes a muting facility which shorts the signal output to ground, so that sound is no longer heard through the PA system. This muting function is completely silent in operation – ie, there are no clicks and pops in the sound when the muting is switched in or out.

As shown in the photos, the unit is housed in a small case which contains a separate battery compartment. The lapel microphone plugs into a socket at the top of the case, while the output lead plugs into a 6.35mm stereo socket on one side.

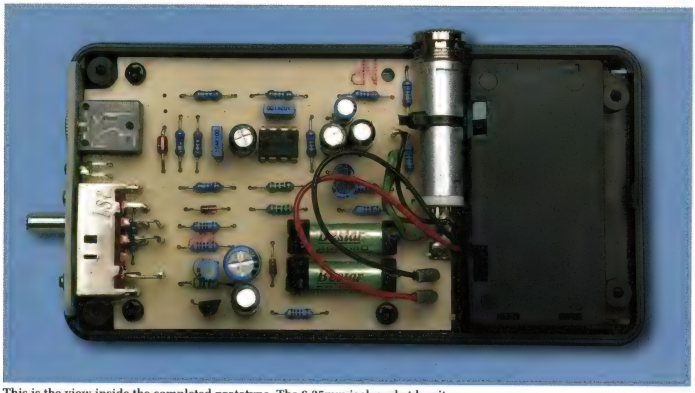
A single 3-position slide switch is used to switch the power on/off and to select the muting. An adjacent green indicator LED flashes when the power is switched on and this can also be used to indicate the battery condition. A bright flash indicates a good battery, with the LED becoming increasingly dim as the battery goes flat.

In addition, the LED serves as an indicator by glowing faintly when the switch is in the Mute position. It also flashes brightly and decays when the unit is switched off, to acknowledge the switch selection.

### Circuit details

Fig.1 shows the full circuit details of the Lapel Microphone Adaptor. It includes a dual op amp package (IC1) to do the audio signal processing, plus two relays to shunt the signal on each balanced line to ground during muting. Power for the circuit is derived from a 9V battery and is applied via reverse polarity protection diode D1 and power switch S1.

The electret microphone is plugged into a mini XLR male socket or a 3.5mm jack socket, depending on the type of electret used. It is powered from the 9V battery via 1kΩ & 22kΩ resistors and a 100µF filter capacitor. This decoupling is necessary to keep supply noise and ripple from degrading the microphone signal.



**This is the view inside the completed prototype. The 6.35mm jack socket has its outer cover removed and is secured to the PC board using a cable tie. The socket is then further secured by its threaded boss when the lid is fastened down.**

The output signal from the microphone is fed to the pin 5 (non-inverting) input of op amp IC1a via a 100nF capacitor. This capacitor and its associated 100kΩ resistor roll off the low-frequency response below 16Hz.

Note that IC1a's pin 5 input is biased at half-supply (ie, Vcc/2) via the 100kΩ resistor which is connected to a voltage divider consisting of two 10kΩ resistors across the 9V rail. This allows the op amp's output to swing symmetrically above and below Vcc/2.

IC1a is wired as a non-inverting buffer stage and provides an output which is in phase with the microphone signal. By contrast, IC1b is connected as an inverting amplifier. It operates with a gain of -1, as set by the two 10kΩ input and feedback resistors.

IC1b is fed from IC1a's output (pin 7) and provides a complementary out of phase signal at its pin 1 output. The 1nF capacitor across the feedback resistor rolls the signal off above about 16kHz to ensure stability.

As a result, IC1a's output provides the in-phase signal while IC1b's output provides the out-of-phase (or inverted) signal. The op amp outputs are then AC-coupled to the output socket via series 10μF capacitors and 560Ω resistors. The 560Ω resistors provide a nominal 600Ω output impedance and prevent the op amps from oscillating (due to the extra capacitance) when the balanced microphone cable is connected.

The 10μF capacitors are necessary to remove the DC levels that are present at the outputs of IC1a and IC1b.

## Muting

As previously mentioned, the outputs can be muted and this is achieved using relays RLY1 and RLY2 which short the outputs to ground when powered.

In addition, the outputs are muted at switch-on. This is necessary because when power is initially applied to op amps IC1a & IC1b (via switch S1b), their outputs quickly rise to half supply (Vcc/2). Without muting, this voltage would be coupled into the PA system and cause large switch-on thumps. To circumvent this, relays RLY1 & RLY2 are switched on at power up to short the signal outputs to ground until the voltages settle.

The relays are switched via switch S1a and its associated circuitry based on transistor Q1. This works as follows.

Switch S1 is a double-pole 3-position switch and when S1 is in position 1, no power is applied to the circuit. In position 2, S1b's contacts feed power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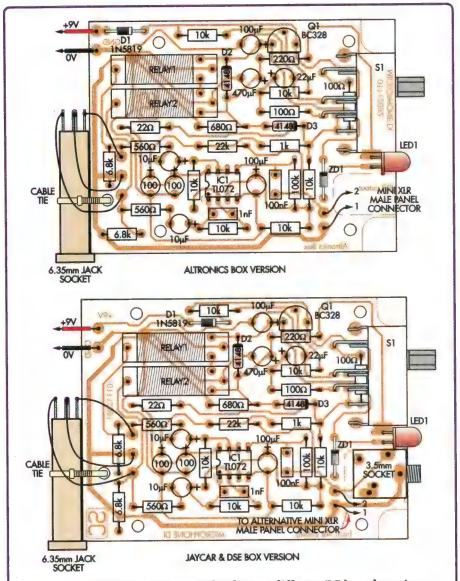
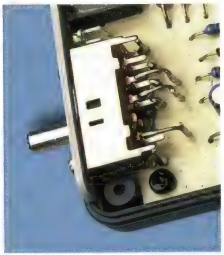



**Fig.2: here are the parts layouts for the two different PC board versions (Altronics top, Jaycar & DSE bottom). Make sure that all polarised parts are correctly oriented and that the correct component is installed at each location. Note that the Altronics version uses an XLR connector for the microphone (ie, there's no provision for a 3.5mm socket).**



**This close-up view shows the wiring details to the double-pole 3-position slide switch. The three switch terminals at the top connect to their corresponding PC stakes via short lengths of tinned copper wire.**

to op amp IC1, while the corresponding contacts in S1a connect transistor Q1's 10kΩ base resistor to ground via a 100Ω resistor. As a result, Q1 turns on and applies power to the relays.

As shown on Fig.1, the relay coils are connected in series, with one side going to ground via a 470µF capacitor and 680Ω resistor connected in parallel. Initially, the 470µF capacitor is discharged and so the full 9V is applied across the series-connected relay coils – ie, 4.5V for each relay. This is quite sufficient to activate the 5V relay coils and close the contacts.

As the 470µF capacitor charges, the voltage across the relay coils decreases. However, the relays remain closed because their dropout voltage is much lower than the voltage required to activate them. The 680Ω resistor sets the minimum voltage across the relay coils to around 2.7V per relay. This resistor is included to reduce the current drawn from the battery while the relays are closed.

The resistor and capacitor also cause LED1 to momentarily flash when the power is switched on. Initially, when power is applied and the 470µF capacitor is discharged, LED1 is fed via a 4.7V zener diode (ZD1) and the series 220Ω resistor. The LED will glow brightly with a fresh battery but as the battery voltage falls to around 7.2V, there will be insufficient current to light it at full brightness.

It works like this: since there is 4.7V across ZD1 and a nominal 2V across the LED, this leaves only 0.5V across the 220Ω resistor when the battery is at 7.2V. As a result, the LED current is only about 2.3mA and so the LED will only glow dimly.

By contrast, if the battery is at 9V, the resistor will have 2.3V across it and so the LED current will be around 10mA. As a result, LED1 will glow brightly. However, the LED does not light for long, as the 470µF capacitor quickly charges via the relay coils and turns LED1 off again.

When S1 is placed in position 3, IC1 is still powered but Q1's 10kΩ base resistor is disconnected from ground. As a result, the 22µF capacitor is now left to supply Q1's base current for a short time as it charges towards the 9V supply rail via the two series 10kΩ resistors. After about 1s, Q1 switches off and the relays also turn off, thereby releasing the shorts across the output lines from IC1a and IC1b.

Diode D3 quenches the back-EMF voltage that's generated when the relay coils are switched off. This back-EMF voltage is further damped by the 100µF capacitor at D1's cathode.

Note that the muting can be reactivated at any time by switching S1 back to position 2, so that the relays are switched on again. In addition, when the power is fully switched off

(S1 switched to position 1), the relays remain on for one second while the 22µF capacitor charges. This ensures that IC1 is fully powered down before the relays are switched off, to prevent loud switching thumps in the PA system.

As a further precaution, the 100µF capacitor that's used to decouple IC1's supply rail is quickly discharged via a 100Ω resistor and position 1 of S1a. Diode D2 is included to ensure that the 470µF capacitor also discharges, so that the relays turn on if power is quickly applied again.

The 22Ω resistor in series with pin 8 of IC1 limits the surge current through the switch when power is applied. Similarly, the 100Ω resistor at position 2 of S1a limits the discharge current from the associated 22µF capacitor when S1a switches this contact to ground.

## Construction

The assembly is straightforward since all the parts are mounted on a single PC board. There are two board versions: one coded 01101041 (86 x 64mm) to suit a Jaycar or Dick Smith Electronics (DSE) case; and one coded 01101042 (81 x 61mm) to suit an Altronics case.

Note that the Altronics version assumes the use of a mini XLR socket for the microphone. There's no provision for a 3.5mm socket on this board.

Regardless of its origin, the specified case measures 135 x 70 x 24mm and includes a separate battery compartment. A small panel label measuring 59 x 16mm is affixed to the top panel of the case.

Begin by checking the PC board for any possible shorts between tracks or breaks in the copper pattern. Check also that the hole sizes are correct. Note that a cutout will need to be made in the board to provide space for a mini XLR panel-mount socket if you are using a lapel microphone fitted with a mini XLR (female) plug.

The XLR cutout is shown as an outline on the PC board. You also need to file the edge of the PC board slightly where shown, to allow room for the XLR securing nut to encroach into the PC board space.

Alternatively, if you are using a microphone with a 3.5mm jack plug, you can use a PC-mount 3.5mm socket instead. In that case, you won't need to make the cutout.

You should also check that the two front corners of the PC board have been cut out to the shape shown. These cutouts are necessary so that the board clears the internal pillars in the case.

**Table 2: Capacitor Codes**

| Value | µF code | IEC Code | EIA Code |
|---|---|---|---|
| 100nF | 0.1µF | 100n | 104 |
| 1nF | .001µF | 1n0 | 102 |

**Table 1: Resistor Colour Codes**

| ❑ | No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|---|
| ❑ | 1 | 100kΩ | brown black yellow brown | brown black black orange brown |
| ❑ | 1 | 22kΩ | red red orange brown | red red black red brown |
| ❑ | 6 | 10kΩ | brown black orange brown | brown black black red brown |
| ❑ | 2 | 6.8kΩ | blue grey red brown | blue grey black brown brown |
| ❑ | 1 | 1kΩ | brown black red brown | brown black black brown brown |
| ❑ | 1 | 680Ω | blue grey brown brown | blue grey black black brown |
| ❑ | 2 | 560Ω | green blue brown brown | green blue black black brown |
| ❑ | 1 | 220Ω | red red brown brown | red red black black brown |
| ❑ | 2 | 100Ω | brown black brown brown | brown black black black brown |
| ❑ | 1 | 22Ω | red red black brown | red red black gold brown |

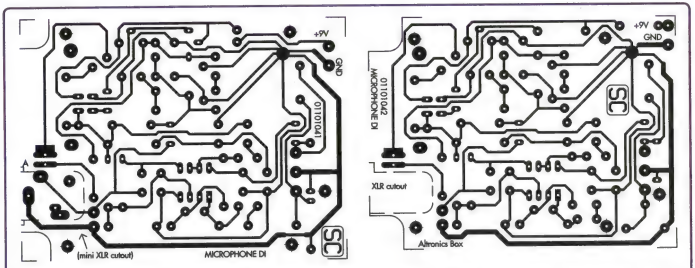



**Fig.3: here are the full-size etching patterns for the two versions of the PC board (Jaycar & DSE left; Altronics right).**

**A right-angle stereo 6.35mm jack plug to 3-pin XLR line plug lead is used to connect the balanced output signal from the Lapel Microphone Adaptor to the PA amplifier.**

Fig.2 shows the assembly details for the two versions. Start by installing all the PC stakes at the wiring and switch terminal points, then install the resistors, diodes D1-D3, zener diode ZD1 and the IC. Make sure you place each component in its correct position and with the correct orientation.

Table 1 shows the resistor colour codes but it's also a good idea to check the values using a digital multimeter as some of the colours can be difficult to distinguish.

The relays and transistor Q1 can go in next, followed by the capacitors. Be sure to install the electrolytic capacitors with the polarity shown. The 3.5mm socket can also now be installed if it is being fitted.

The 3-position switch (S1) is mounted on its side, with its top face aligned with the edge of the PC board. Five of its bottom terminals are soldered directly to the previously installed PC stakes as shown on Fig.2, while three of the top terminals connect to their PC stakes via short lengths of tinned copper wire.

## Drilling the front panel

The front panel can now be drilled to accept the switch, LED and microphone input socket. That done, attach the front panel label, then attach the front panel to the PC board assembly by installing the supplied switch screws and by fitting the securing nut to the 3.5mm jack socket.

That done, the LED's leads can be bent at right angles about 4mm from its body and the LED slipped into position so that it protrudes through the front panel. Adjust its leads as necessary and make sure that it is oriented correctly before finally soldering it into position.

In particular, note that anode lead (A) is the longer of the two. This lead goes towards the bottom edge of the PC board as shown on Fig.2.

## 6.35mm jack socket

A hole is needed in the side of the box for the 6.35mm jack socket which is used without its outer cover. Mark the hole location with the case clipped together, noting that the socket sits directly on the PC board and against the battery compartment.

The mounting hole must be drilled and reamed out to 10mm diameter, which will not be large enough for the threaded section of the socket. That done, place the PC board in the case and secure it in position using three M3 screws (two at the top and one at bottom right).

Next, position the socket in its mounting hole and tighten down the case lid with the four self-tapping screws supplied. Now heat the socket using your soldering iron until the plastic case begins to melt, at the same time pressing the case together so that it forms a tight fit around the socket and closes correctly.

Finally, remove the iron and wait

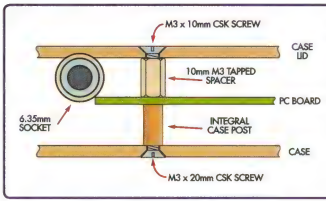



**Fig.4: this diagram shows how the M3 x 10mm tapped spacer is secured to the PC board. This helps secure the 6.35mm socket when the lid is screwed down.**

**Fig.5: this artwork can be used as a drilling template for the front panel.**

for the heated case to cool.

The case will now have formed a moulding around the threaded section of the 6.35mm jack socket. It should then be prised open again and the socket secured in position using a cable tie which passes through a hole in the PC board and then around the edge of the board.

To further secure the socket, a 10mm M3 spacer is installed on the PC board adjacent to it so that the lid can be firmly screwed down at this point. To do this, the mounting post in the base of the case adjacent to the socket is drilled out to 3mm and this hole goes right through the case. In addition, you have to drill out the post in the case lid directly above this point.

That done, countersink the holes and cut off the post in the lid using a sharp utility knife. The 10mm M3 spacer can then be fitted in position and secured using an M3 x 20mm screw installed from the bottom of the case as shown in Fig.4.

All that remains now is to complete the wiring to the stereo socket and connect the battery clip lead. Note that the leads from the battery clip will have to be fed through from the battery compartment before soldering them to the supply terminals on the PC board.

## Testing

To test the unit, apply power and check that the relays close and that the LED flashes. If not, check that transistor Q1 has been installed correctly and check its associated components. If the relays do close but the LED doesn't flash, check that the LED has been installed with the correct polarity and check the orientation of ZD1.

Finally, check that pins 1 & 7 of IC1 are at about 4.5V (ie, Vcc/2). This voltage should also be present on pins 3 & 5 (ie, the non-inverting inputs). If everything checks out, then it is likely that the unit is working correctly and is can be tested by connecting it to a PA system and plugging in a microphone. SC

**Fig.6: this is the full-size artwork for the case label.**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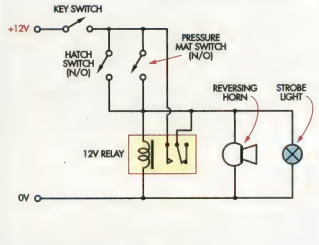
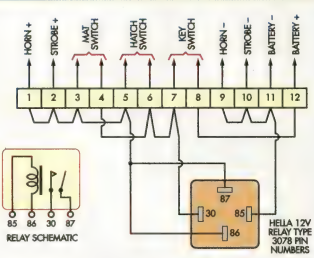
# CIRCUIT NOTEBOOK

**Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.**




CIRCUIT




WIRING DIAGRAM

## Low cost burglar alarm for boats

This low-cost burglar alarm employs a 12V strobe light and a truck reversing horn as the visible and audible alarm outputs while the alarm itself is a 12V horn relay and some pressure mat switches.

This simple approach has the benefit that the alarm continues to operate even if the entry point is immediately closed and it draws no current while in the armed condition. To make it independent of the boat supply it runs from a single 12V or two 6V alkaline lantern batteries connected in series. These should last well in excess of two years.

An advantage of a lantern battery is that it will last less than an hour while powering the alarm in its active role. This means the alarm system will not seriously contravene noise pollution laws. If there are very strict noise regulations in your area, you can fit an alarm timer, available from some electronic shops, in the circuit between the battery positive and the key switch.

The key switch can be installed in the cockpit bulkhead and connects to two normally open (NO) switches wired in parallel. One switch is a pressure mat placed on the cockpit floor near the entry, underneath a suitable piece of carpet or pliable cover. If a pressure mat is unsuitable, the main entry can be protected by a mechanical switch such as an automobile boot lid or door courtesy light switch.

The second switch can be used to protect against entry through a forward hatch or second wheelhouse door. Any number of normally open (NO) switches can be installed in this system, all wired in parallel.

If the alarm is tripped, the relay closes and latches on due to the wiring of its contacts and the horn and strobe light are powered.

The suggested truck reversing horn is the Hella 6023 intermittent reversing buzzer which has an 85dB sound level and a current drain of 0.9A at 12V. The suggested strobe is a Hella 1657 which has an amber lens in a weatherproof housing. This strobe flashes about once per second and the current drain at 12V is 0.25A.

The strobe can be installed outside on deck or in the main cabin where its flash will be seen through most ports and windows. Wiring to both the warning horn and strobe light should be concealed.

**Dave Jeanes,**
**Banora Point, NSW. ($35)**

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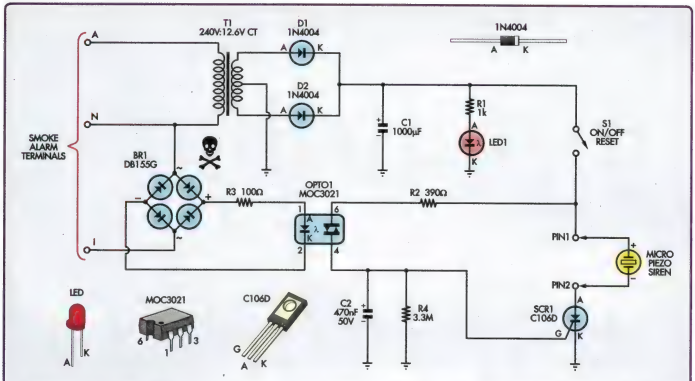



## Remote alarm for smoke detector

This alarm circuit was designed to monitor a mains-powered smoke detector located in a shed (which is used to house dog kennels). It provides complete isolation from the mains so that low-voltage (12V) cabling could be run to the alarm circuit which is located inside the house.

In operation, the alarm signal (I) from the smoke detector is rectified using bridge rectifier BR1 and then fed to optoisolator OPTO1 via resistor R3. This in turn drives the gate of SCR1 which turns on and activates a piezo siren with inbuilt oscillator.

Power for the circuit is derived via mains transformer T1. This drives a full-wave rectifier based on diodes D1 & D2 to produce around 9V DC and this is then applied to the alarm circuit via switch S1. Capacitor C1 filters the supply rail, while LED1 provides power-on indication.

When the alarm is triggered, it latches on until reset by S1 (ie, the switch must be opened and then closed again).

Finally, a relay could be connected between pins 1 & 2 to switch larger loads than the piezo siren – eg, to turn emergency lights on.

**Troy McDonaugh,**
**Loganholme, Qld. ($35)**

Editor's Note: this circuit is recommended for experienced constructors only. In particular, **note that all parts to the left of the MOC3021 optocoupler, including BR1 and R3, are at mains (240VAC) potential.**

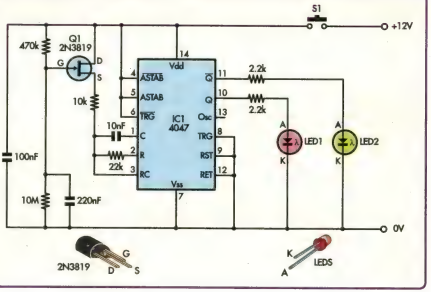
## Yes-No indicator has zero standby current

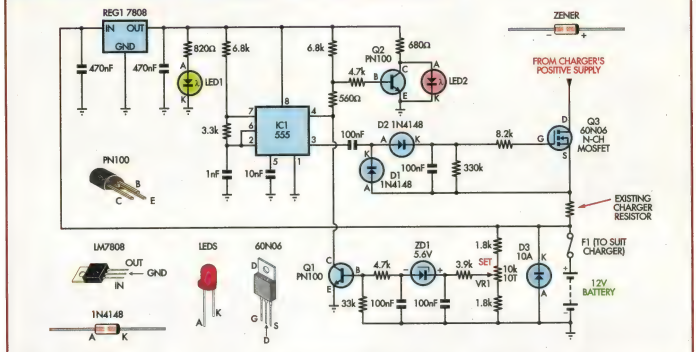
This circuit produces a random "Yes" or "No" with a single button press – indicated by the illumination of a red or green LED. The circuit has two advantages over similar circuits.

First, it uses just a single momentary contact pushbutton, so no on-off switch is required. When the pushbutton is pressed, an oscillator comprising the 10nF capacitor and 22kΩ resistor at pins 1 & 2 is almost immediately stopped by FET Q1, which pulls the oscillator's timing capacitor to the positive rail.

However, the 220nF capacitor and

*continued on page 64*






## Battery charger regulator

Most off-the-shelf car battery chargers cannot not be left connected to the battery for long periods of time as over-charging and consequent battery damage will occur. This add-on circuit is placed in series with the battery being charged and is powered by the battery itself.

In effect, the circuit uses a high-current Mosfet to control the charging current and it turns off when the battery voltage reaches a preset threshold.

Power for the circuit is fed from the battery to 3-terminal regulator REG1 which provides 8V. LED1 indicates that the battery is connected and that power is available.

The 555 timer IC is configured as an astable oscillator running at approximately 100kHz. It feeds a diode pump (D1 & D2) to generate adequate gate voltage for Mosfet Q3, enabling it to turn on with very little on resistance (typically 14 milliohms).

With the Mosfet turned on, current flows from the charger's positive terminal so that charging can proceed. The battery voltage is monitored by 10kΩ pot VR1. When the wiper voltage exceeds the conduction voltage of zener diode ZD1, transistor Q1 turns on and pulls pin 4 (reset) low to switch off the 555 and remove gate drive to the Mosfet.

This process is progressive so that the cycle rapidly repeats itself as the battery charges. Eventually, a point is reached when the battery approaches its charged condition and the cycle slows right down.

Transistor Q2 and LED2 function as a cycle indicator. When the battery is under charge, LED2 appears to be constantly on. When the battery is fully charged, LED2 briefly flicks off (charging) and returns to the on state (not charging) for a longer period.

**Paul Walsh,**
**Montmorency, Vic. ($40)**

## Yes/No Indicator – continued from page 63

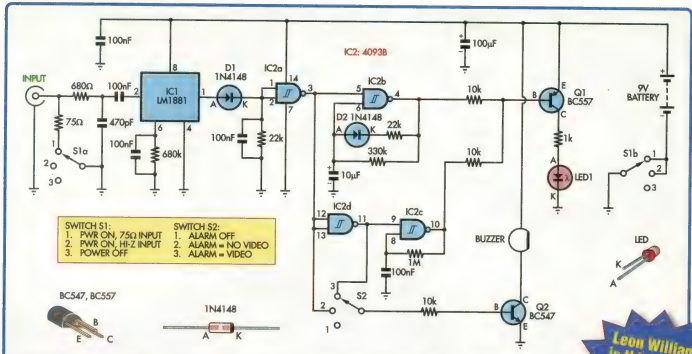
470kΩ resistor in the gate circuit of Q1 introduce a tenth of a second's delay, so that about 250 oscillations take place before the clock is stopped. Due to variations in charge on the circuit's capacitors, as well as voltage and temperature variations, and the unpredictability of when the pushbutton will be pressed, randomness is assured.

The circuit has a high degree of randomness because it takes advantage of a near-perfect complementary square waveform at pins 10 and 11 of the 4047 IC. The oscillator frequency (available at pin 13) is passed through an internal divide-by-2 circuit in the 4047. This appears at pin 10 (Q), and is inverted at pin 11 (Q-bar), thus assuring a near perfect 50:50 duty cycle for the two LEDs.

Note, however, that the "impartiality" of the circuit is partly contingent on the value of the 10nF capacitor and on a reasonably equal current flow through both LEDs.

Over five trials, the Yes-No Indicator scored 142 Yes, 158 No, with Yes falling behind No in the fourth trial. Because the circuit only works while switch S1 is pressed, standby current is zero, therefore a miniature 12V battery may be used to power it. In this case the circuit could be used thousands of times before the battery would run flat.

The circuit has a further potential




## Video tracer for trouble-shooting

This circuit was designed as an aid to installers and maintainers of video systems. It is basically a video sync separator (IC1) followed by a LED and buzzer driver (IC2, Q1 & Q2).

In use, the device is connected to a video cable and if there is video present, the LED will flash at about 10Hz. If there is no video, the LED flashes briefly every couple of seconds.

A buzzer can also be switched in to provide an audible indication. The buzzer is particularly useful when tracing cabling faults or trying to find a correct cable amongst many, where it is difficult to keep an eye on the LED.

Another use for the buzzer option is to provide a video fault indication. For example, it could be inserted in bridging mode, with switch S1 in high impedance mode (position 2)) across a video line and set to alarm when there is no video present. If someone pulls out a cable or the video source is powered off, the alarm would sound.

IC1 is a standard LM1881 video sync separator circuit and 75Ω termination can be switched in or out with switch S1a. The other pole of the switch, S1b, turns on the power. The composite sync output at pin 1 is low with no video input and it pulses high when composite sync is detected.

These pulses charge a 100nF capacitor via diode D1. When there is no video at the input, oscillator IC2b is enabled and provides a short pulse every couple of seconds to flash the LED. The duty cycle is altered by including D2, so that the discharge time for the 10µF capacitor is much shorter than the charge time. The short LED pulse is used as a power-on indicator drawing minimal average current.

When video is present at the input, IC2b is disabled and IC2d is enabled. The output of IC2d provides a 10Hz square wave signal to flash the LED.

The buzzer is controlled by switch S2. In position 2 the buzzer will sound when there is video at the input and in position 1 the buzzer will sound when there is no video at the input.

**Leon Williams, Bungendore, NSW.**

**Leon Williams is this month's winner of the Peak Atlas LCR Meter**

use. If the LEDs are omitted and a piezo (capacitive) sounder is wired directly to pins 10 and 11, it will produce a loud beep when equipment is turned on, and will continue to draw less than 0.5mA until it is switched off. The frequency of the beep may be changed by altering the value of the 10nF capacitor and its duration by altering the value of the 220nF capacitor.

**Thomas Scarborough, Capetown, South Africa. ($35)**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RRP $299
**Q 1098**

**BONUS! Each Q 1098 comes with a FREE Q 1092 temperature probe, valued at $23.10!**

**SAVE OVER $100!**

## Give your car stereo a big BOOST!

**SAVE $50 Hurry, limited stocks!**

$149
RRP $209
**C 5041**

Great addition to any car audio system. Ideal for driving subwoofers, featuring;

*• 2 Channel (2 x 60W RMS) • Minimal distortion, exceptional frequency response • Anti theft design with removable end caps • High and low level inputs • Variable crossover • Bridgeable • Latest moslet design*

## Trigger your alarm when a window breaks

NEW

$39
RRP $49.95
**S 5305A**

***NEW COMPACT MODEL!***

Protects your windows from unauthorised entry. With high and low frequency detection for false alarm prevention. **Features:** • NC contacts • 9m range • 12VDC powered. • Alarm indicators.

## Modular RJ45 Plugs

45¢
RRP $0.95
**P 1418**

Make your own leads! **SUPER LOW PRICE.**

***100 minimum**

## Build your own speaker system!

...or refurbish those old favourites!

A fantastic choice for building into custom subwoofer cabinets for car, home theatre or hi-fi. Consult catalogue or website for full specs. All 8Ω

***NEW 10 INCH MODEL!***

| | 6.5"/80W | 8"/100W | 10"/100W | 12"/160W |
|---|---|---|---|---|
| | **C 3022** | **C 3024** | **C 3025** | **C 3030** |
| RRP | $49 | $69 | $89 | $109 |
| Singe | $40 | $59 | $79 | $99 |
| | ***buy two or more & save*** | | | |
| Two+ | $35 | $50 | $70 | $89 |

## Save $40!

## 180W Active Subwoofer

**Add some OOMPH to your movies! Subwoofers add mind blowing realism to your home theatre system.** This sub features a 180W 10 inch driver with built in amplifier rated at 0.1% THD. A stunning frequency response of 35Hz-1KHz. The unit also features level control, frequency crossover adjustment and a phase reversal switch.

**Allow an additional $20 to road freight to anywhere in Australia.*

$389*
RRP $429
**C 5200**

## Infra Red Detectors

**WITH 5 YEAR WARRANTY**

$30 ea
or $25 ea 4UP
RRP $35
**S 5314**

## Aluminium Tool Case

Rugged aluminium construction! Measures 460 x 325 x 150mm

"Tools shown not included

$49
RRP $94.90
**T 5020A**

Beware of interior quality cheaper models on the market which have plastic sides and are less robust.

## Secure your rollerdoor

NEW

**Rugged, bulletproof construction!**

$24.95
**S 5159**

For triggering your home alarm when a burglar lifts your rollerdoor up. Sturdy all aluminium construction. Tamper proof design. NC contacts.

## 6 SECTOR ALARM SYSTEM

**NOW WITH DIALLER!**

***Protect your family, possessions and home from criminals***

**By far the BEST alarm panel we have evaluated.** Incredibly easy to install and program yourself!! Now includes a telephone dialler which instantly dials up to 4 numbers and plays a pre recorded message when the alarm is triggered. With the use of the optional remote monitoring software (S 5266 $179.00) you can dial into the system and get information on where the break in has occurred. M 9332 plugpack to suit $25.25, S 5075 Backup battery to suit $24.50

**ALARM BONUS!**
**Every S 5264 includes a FREE S 5462 siren cover and S 5445 blue flashing strobe (Valued at $42.95).**

$399
**S 5264S**

## A third hand for hobbyists!

T 1450

***Everyone can do with a third hand when gluing, painting or soldering - right?*** Well these handy holders will help out! Perfect for model makers and electronic enthusiasts.

$8
RRP $10.45
**T 1450**

$14
RRP $17.60
**T 1460**

T 1460

## Dynamic Mic Headset

This sturdy, high quality headset can be used with just about any handheld CB/UHF radio/ Great for communications. Comfortable enough to wear all day with easy adjust headband and mic boom.

**FREE! Your new C 9064 will arrive with a protective carry bag Valued at $24.75**

NEW

$249
C 90645

## Portable PIC Programmer

**(SC Sept. '03)** This battery powered programmer kit is suitable for: PIC16F and 12F, 16F87X series. 24CXX EEPROMS.

$49.95
K 9505

***BEWARE OF CHEAPER KITS THAT DO NOT INCLUDE ZIF SOCKET AND CABLES OR EVEN A PIC CHIP (16F84). OURS HAS THE LOT!***

## Portable Frequency Meter Kit

**(SC Oct'03)** Terrific for the service person or techie on the road. Completely portable 50MHz meter with high and low resolution modes

$69.95
K 2540

## Remote control your PC!

**(SC Aug' 03)**

**Wonderful gift idea for the PC enthusiast!** Provides remote control of Winamp and WinDVD software as well as a host of other PC automation abilities.

$29.95
K 27555

*Great for watching DVD's or playing MP3's*

**BONUS DEAL! For just $10 extra, get a A 1013 remote to suit. Valued at $31.50**

## SLA Batteries

Premium grade long life. *1000's sold to security companies across Australia!*

| | 12Ah | 3Ah | 7.0Ah |
|---|---|---|---|
| | S 5075B | S 5080 | S 5090B |
| RRP | $24.50 | $32.50 | $39.50 |
| This Month | $20 | $25 | $30 |
| | ***even better, buy a pair!*** | | |
| 2 up | $15 | $20 | $25 |

## PRO HARD DRIVE COOLER

NEW

*Extend your hard drives life! Reduce the chance of data loss!* Featuring an LCD which shows disk activity, temperature, fan status, master/slave configuration, alarm conditions and PC uptime. Temperature can be measured from up to 3 positions inside your PC

$94.50
D 5515

*Made by the world famous Thermaltake®*

## Wireless communication!

NEW

This Bluetooth USB dongle allows quick and easy communication with other bluetooth devices such as access points, PDA's, phones and other computers. 10m range.

$49.95
D 0380

## Clamp Meter Adaptor Kit

**(SC September '03)** Simple yet effective AC/DC clamp meter adaptor for your multimeter.

$22.80
K 2582

## Datalogging DMM with Isolated RS232

The **Brymen® BM202** has features usually found in meters 2 or 3 times the price! Its datalogging feature is fantastic for those monitoring battery charge rates, graphing temp variations etc.

*Features:*
- Optically isolated for safe operation • Auto ranging • EF mains detect • Data hold • Temperature • AC/DC voltage • AC/DC current • Resistance • Diode check & buzzer • Frequency meter

$125
RRP $149
D 10805

**FREE! Q 1082 RS232 Optical PC interface to suit, valued at $24.95!**

## Turn your PC monitor into a TV

**WHAT A FANTASTIC PRODUCT!**

This standalone box can hook straight up to any PC monitor and provides clear TV or video up to a whopping 1024 x 768 resolution AND without the blurryness of cheaper PC cards. Features: • Built in TV tuner • SVHS & RCA inputs • Full function remote control

$225
D 3590

NEW

*Sit back and watch TV or play console games, all on a PC*

## Feature Packed DMM

**19 RANGES! BACKLIGHTING! TEMP PROBE! Its got the lot!** Outstanding compact meter for the trades person on the move.

**Features:** • DCV to 600V • ACV to 600V • DCA to 10A • Resistance to 2000KΩ • Logic Test • Continuity Buzzer • Transistor Hfe • Data Hold.

$25
RRP $32.95
Q 1126

## Stylish rack cases.

## Internal AND external card reader?

NEW

*THAT'S RIGHT!* This great little 6 in 1 card reader/writer bolts inside your PC but also sprngs out to become an unit when your on the road! Suits CF, SM, SD, MMC, Microdrive and Memorystick cards.

$65
D 0372

## Get your point across!

With this great keychain laser pointer. Ideal for lectures, seminars, building sites and guided tours. *GREAT GIFT IDEA!*

**Maximum permitted 1mW power output**

$12
RRP $14.95
A 0205

## Make your data TOTALLY portable

NEW

$115
D 5530 2.5"

$99
D 5535 3.5"

These aluminium hard drive cases allow you to move your data around easily. They accept either 2.5" or 3.5" drives and connect via your PC's USB port (D 5530 also has Firewire). Ideal for travellers or people on the move!

## 1.5A Power Supply

**Great compact tent bench supply!**

Delivering 3, 4.5, 6, 7.5, 9 and 12V at up to 1.5A continuous capacity. Excellent for voltage sensitive devices like portable TV sets, video games, radios, scanners. In-built short circuit and overload protection.

$30
RRP $49
M 8230

**Near low price. Save up to 30%!**

**Give your project a touch of class!**

| | 1U | 2U |
|---|---|---|
| | H 5031 | H 5032 |
| RRP | $69 | $99.75 |
| This Month | $62 | $85 |
| Or buy 2.. | $50 | $75 |

## Very very own weather station

**Fantastic gift idea!**

A stylish blue backlit hygrometer, barometer and thermometer unit. The handy barometer predicts the weather ahead of time! Also features alarm clock (with snooze), date and day display.

$55
RRP $79.95
A 0170

## Cheap insurance for all your appliances!

The **QUICK** and **EASY** way to protect your equipment from damaging electrical surges and spikes.

**Great for protecting ADSL modems!**

| | 1 Way+Phone | 6 Way | 6 Way+Phone |
|---|---|---|---|
| | P 8131 | P 8141 | P 8151 |
| RRP | $22.95 | $29.00 | $32.00 |
| This Month | $15 | $20 | $25 |

## Pocket Rocket Blowtorch!

It may be small but it packs a *mean* punch! One flick of the trigger and you have a whopping 1300°C flame ready for brazing, heavy duty soldering or heatshrinking.

Featuring: • One handed operation • Safety ignition lock • Refillable gas cartridge • Compact design.

**Perfect for quick jobs!**

$19
RRP $24.95
T 2490

## Save space and money with a KVM switch

A KVM switch allows you to share a single monitor, mouse and keyboard with 2 computers. Don't waste money on buying a second lot of peripherals. Save heaps of desk space in the process. Features high quality, filtered VGA lead.

**Run 2 PC's on a single monitor, mouse and keyboard!**

$89
D 1629

## All in ONE Mini tool kit

*Pick one up for the glovebox!* Includes:
- Sidecutters • Pliers • 6 screwdrivers • Tweezers
- Handle plus extension bar
- 7, 8, 9 & 10mm sockets
- 2 philips, 2 slotted and 5 star bits

*Excellent gift idea!*

$15
RRP $20.95
T 2170


## ALTRONICS

**Phone 1-300 797 007, Fax 1-300 789 777**

**MAIL ORDERS** C/- P.O. Box 8350 Perth Business Centre, W.A. 6849

**Altronics Retail Store:** 174 Roe St. Perth W.A. 6000

Diners Club | Amex | Bankcard | MasterCard | VISA

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# PRODUCT SHOWCASE

## Altronics opens Sydney retail, wholesale centre

Perth-based electronics importer, wholesaler and retail company Altronics is set to expand significantly into the eastern states with the opening of a brand new, purpose-built facility in the inner western suburbs of Sydney.

The new complex will include a fully stocked warehouse and showroom catering for wholesale, trade and retail customers.

This venture represents a major milestone in the company's 27-year history and further enhances the ability to service NSW and eastern states customers.

The 2000m$^2$ premises are located in Short Street, Auburn (near Bunnings and the Mega Mall) and will be open for business on Monday, 9th February.

## Intel demonstrates 65nm SRAM technology

Intel Corporation has built fully functional SRAM (Static Random Access Memory) chips using 65nm (nanometer) technology, its next generation high-volume semiconductor manufacturing process. Intel is on track to put this process into production in 2005 using 300mm wafers.

This new 65nm (a nanometer is one-billionth of a metre) process combines higher-performance and lower-power transistors, a second-generation version of Intel's strained silicon, high-speed copper interconnects and a low-k dielectric material. Building chips using the 65nm process will allow Intel to double the number of transistors it can build on a single chip today.

Only 20 months have elapsed since Intel achieved fully functional SRAMs on their 90nm process. Intel's new 65nm process will feature transistors measuring only 35nm in gate length, which will be the smallest and highest performing CMOS transistors in high-volume production. By comparison, the most advanced transistors in production today, found in Intel Pentium 4 processors, measure 50nm.

Contact:
**Intel Australia Pty Ltd**
Level 17, 111 Pacific Hwy North Sydney NSW 2060
**Tel:** (02) 99375800 **Fax:** (02) 9937-5899
Website: www.intel.com/research/silicon

## DSE 50MHz Frequency Meter kit

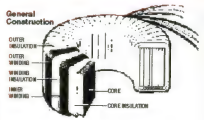
Dick Smith Electronics have sent us one of their kits for the SILICON CHIP 50MHz Frequency Meter (October 2003) – and we have to say that we are impressed!

While the electronics are as published, they've gone to a lot of trouble to make the kit look very professional indeed. Most noticeable is the front panel, screen printed on a thick steel pre-punched plate. This has allowed the use of countersunk-head screws to give a very flat panel.

The kit sells for $79.88 and comes complete with comprehensive instructions. It is available through all DSE stores (including PowerHouse), mail orders and most resellers.

Contact:
**Dick Smith Electronics**
PO Box 500, Regents Park DC NSW 2143
**Tel:** 1300 366 644 **Fax:** 02 9642 9155
Website: www.dse.com.au


**TOROIDAL POWER TRANSFORMERS**




**Manufactured in Australia**
**Comprehensive data available**
**Harbuch Electronics Pty Ltd**
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

## New Goodies from Microgram

Serial ATA (SATA) Hard Drives are relatively new technology to the PC industry. The main appeal of this new technology is the gain in speed. Microgram Computers has a range of SATA PCI cards and adapters to provide the solutions to many problems.

Microgram has a range of adapters that allow SATA drives to be used in any situation. For example, to plug a SATA drive into an IDE motherboard, or convert an IDE drive into a SATA connector. SATA power adapters from regular 12V molex plugs are also available along with 45cm and 60cm serial ATA cables.

Microgram have also increased their range of USB products, including a USB port extender which can allow USB devices (eg, webcams) to be used up to 50m away via Cat.5 cable.

They also have a USB Watchdog Timer which connects to a USB port and to the reset contacts on the computer motherboard. If the computer locks up and fails to reset, the device then applies a hardware reset to the PC.

Contact:
**Microgram Computers**
PO Box 500, Regents Park DC NSW 2143
**Tel:** (02) 4389 8444 **Fax:** (02) 4389 8388
Website: www.mgram.com.au

## Waterproof VHF & UHF Two-Ways from Icom

Icom Australia has two new handheld commercial transceivers which will be very much sought after by anyone needing radios in wet or potentially wet situations.

The ultra-compact handhelds (56 x 97 x 37mm) are fully waterproof to JIS grade 7 (1m for 30min) so can handle a huge variety of damp, wet or dirty applications.

There are two models, one covering the VHF band from 136-174MHz; the other covering UHF in either 400-470MHz or 450-520MHz bands. In both cases, a 1700mAh Li-ion battery provides 10 hours operation. An alphanumeric readout can be programmed to display channel or frequency information.

RRP is around $800 plus appropriate charger and an optional waterproof speaker/mic is also available for $178.

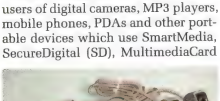
Contact:
**Icom Australia**
290-294 Albert St, Brunswick Vic 3056
**Tel:** (03) 9387 0666 **Fax:** (03) 9387 0022
Website: www.icom.net.au

## Oatley's $6.90 Card Readers: dazzling bargain!

We can never resist a bargain . . . and these card readers from Oatley Electronics definitely fall into that category.

At the moment they have a series of "Dazzle" brand USB card readers, for users of digital cameras, MP3 players, mobile phones, PDAs and other portable devices which use SmartMedia, SecureDigital (SD), MultimediaCard (MMC) and Compact Flash (CF) cards. And the best part is the price: $6.90 each (or even cheaper if you buy three types).

We tried out one of the SmartMedia readers and it was immediately recognised and usable without having to load any driver software (The pic at left is proof of the pudding. . .) But if you need drivers, Oatley's website will point you in the right direction.



Contact:
**Oatley Electronics**
PO Box 89, Oatley NSW 2223
**Tel:** (02) 9584 3563 **Fax:** (02) 9584 3561
Website: www.oatleyelectronics.com

## MPEG over IP

NewTek Sales has been appointed distributor of IneoQuest MPEG over IP technology solutions for cable operators and equipment manufacturers pursuing video-on-demand (VOD) applications.

Gigabit Ethernet LAN topologies that use IP as the transmission medium are now being used as an enabling technology for cable operators providing video-on-demand (VOD) programming to their subscribers. The potential for signal degradation exists any time video signals are manipulated, including the MPEG compression process used to optimise bandwidth use in digital transmission. With VOD, MPEG is combined with Ethernet networks, resulting in a demanding application with critical compression factors. This elevates the importance of signal analysis and monitoring for standards compliance and to assure quality of service.

Contact:
**NewTek Sales**
11 Lyon Park Rd, North Ryde NSW 2113
**Tel:** (02) 8888 0100 **Fax:** (02) 8888 0125
Website: www.newteksales.com

## Online digital photo ordering service

BigPond has teamed with Hanimex to be the first Australian ISP to tap the explosive digital camera boom with a new online digital photo printing service.

Customers can simply upload digital pictures to the BigPond site Bigpond.fujicolor.com.au, select the finish they want and choose between collecting processed prints from Fujifilm Digital Photo Labs.

Photos@BigPond is launching at a time when more than 1.6 million Australians are expected to purchase digital cameras in the next 12 months and camera-phones rival DVD players as the world's fastest selling electronic device.

The new service is ideal for digital camera enthusiasts ready to make the move to broadband.

Contact:
**Hanimex**
114 Old Pittwater Rd, Brookvale NSW 2100
**Tel:** (02) 9466 2600 Fax: (02) 9938 1975
Website: www.bigbond.fujicolor.com.au

# SILICON CHIP WebLINK

**How many times have you wanted to access a company's website but cannot remember their site name?**

**Here's an exciting new concept from SILICON CHIP: you can access any of these organisations instantly by going to the SILICON CHIP website (www.siliconchip.com.au), clicking on WebLINK and then on the website graphic of the company you're looking for. It's that simple. No longer do you have to wade through search engines or look through pages of indexes – just point'n'click and the site you want will open!**

Your company or business can be a part of SILICON CHIP'S **WebLINK**. For one low rate you receive a printed entry each month on the SILICON CHIP **WebLINK** page with your home page graphic, company name, phone, fax and site details plus up to 80 words of description – and this is repeated on the **WebLINK** page on the SILICON CHIP website with the link of your choice active. Get those extra hits on your site from the right people in the electronics industry – the people who make decisions to buy your products. Call SILICON CHIP today on (02) 9979 5644

• Hifi upgrades & modification products - jitter reduction and output stage improvement.
• Danish high-end hifi kits - including pre- amps, phono, power amps & accessories.
Speaker drivers including Danish Flex Units plus a range of accessories.

**Soundlabs Group**
**Syd: (02) 9660-1228 Melb: (03) 9859-0388**
**WebLINK: soundlabsgroup.com.au**

International satellite TV reception in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists, etc or call for appointment to view. We can display all satellites from 76.5° to 180°.

**Av-COMM Pty Ltd**
**Tel:(02) 9939 4377 Fax: (02) 9939 4376**
**WebLINK: avcomm.com.au**

Our website is updated daily, with over 5,500 products available through our secure online ordering facility.
Features include semiconductor data sheets, media releases, software downloads, and much more

**JAYCAR ELECTRONICS**
**Tel: 1800 022 888**
**WebLINK: www.jaycar.com.au**

A 100% Australian owned company supplying frequency control products to the highest international standards: filters, DIL's, voltage, temperature compensated and oven controlled oscillators, monolithic and discrete filters and ceramic filters and resonators.

**Hy-Q International Pty Ltd**
**Tel:(03) 9562-8222 Fax: (03) 9562 9009**
**WebLINK: www.hy-q.com.au**

We specialise in providing a range of Low Power Radio solutions for OEM's to incorporate in their wireless technology based products. The innovative range includes products from **Radiometrix**, the World's leading manufacturer.

**TeleLink Communications**
**Tel:(07) 4934 0413 Fax: (07) 4934 0311**
**WebLINK: telelink.com.au**

At **QUESTRONIX** we specialise in conversion, switching and distribution equipment for VGA, video and audio. We have been serving the audiovisual industry as well as pro, semi-pro and domestic a-v equipment users since 1988. As well as being a 100% Australian manufacturer we also import a range of innovative and interesting items.

**QUESTRONIX**
**Tel: (02) 4343 1970 Fax: (02) 4341 2795**
**WebLINK: www.questronix.com.au**

BitScope is an Open Design Digital Oscilloscope and Logic Analyser. PC software drives BitScope via USB, Ethernet or RS232 to create a powerful Virtual Instrument. BitScope is available built and tested or in kit form. Extensive technical details are available on the website. Great for hobbyists, university labs and industry.

**BitScope Designs**
**Contact: sales@bitscope.com**
**WebLINK: bitscope.com**

JED designs and manufactures a range of single board computers (based on Wilke Tiger and Atmel AVR), as well as LCD displays and analog and digital I/O for PCs and controllers. JED also makes a PC PROM programmer and RS232/RS485 converters.

**Jed Microprocessors Pty Ltd**
**Tel: (03) 9762 3588 Fax: (03) 9762 5499**
**WebLINK: jedmicro.com.au**

## NEXT MONTH: Looking at LEDs (but not looking too closely!)

In next month's SILICON CHIP we plan on taking a look at some of the newer LEDs now available and coming onto the market.

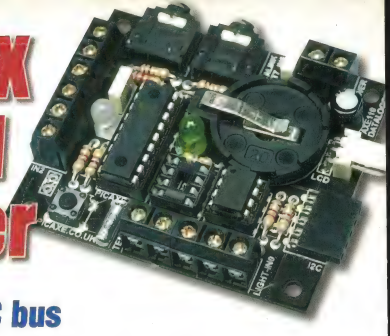
But we won't be looking too closely because some of today's LEDs are so bright that you run the risk of eye damage.

For example, Prime Electronics has an advert in this issue containg several high-brightness LEDs (up to 5W!) which are so bright you hurt your eyes if you look directly into them. And we're not just talking the usual colours – just about any colour you want is now available in LEDs.

There are also some new flashing LEDs on the market (being advertised by Prime Electronics and by Oatley Electronics which go way beyond the old (boring!) flashing red – these little beauties can flash red, green, blue, or red, blue or red green . . . or red/blue, green/red, blue/green – and they too are very bright.

Don't miss this feature next month – but in the meantime, check out both the Oatley Electronics and Prime Electronics adverts in this issue, and also their websites for more information.

# PICAXE-18X 4-channel datalogger




## Pt.1: exploring the I²C bus

**This PICAXE-18X Datalogger is a highly versatile 4-channel data acquisition system. Based on one of the PICAXE series of microcontrollers, it's easy to use and reprogram, enabling the end user to perform many different types of logging experiments.**

By CLIVE SEAGER

Basically, this datalogger consists of four input channels that can be sampled and stored (logged) at user-defined intervals. One channel is dedicated for use with a digital temperature sensor, whereas the remaining three can be used as analog or digital inputs. Logging can be carried out at regularly spaced intervals (typically one minute to several hours), or an optional real-time clock (RTC) chip can be added to ensure accurate logging intervals over longer periods (once a week, once a month, etc). Use of the RTC will be covered in next month's article.

Data is saved in an onboard EEPROM memory chip. If desired, this memory chip can be upgraded for increased memory capacity. An optional memory expansion board can also be used to greatly increase memory capacity.

### Main Features

- Low-cost design
- Four logging channels
- One dedicated digital temperature sensor channel
- EEPROM data storage (easily expandable)
- PICAXE micro means simple programming
- 3 x AA battery operation, low power consumption
- Small footprint (approx. same size as 3 x AA cells)
- Optional real-time clock with lithium battery backup

Once the "mission" is complete, data can be uploaded for analysis on a computer. Data can also be displayed (at the time of logging) on an optional liquid crystal display (LCD) if desired.

The PICAXE-18X datalogger makes extensive use of the I²C bus for communication between ICs. Therefore, before proceeding any further let's take a detailed look at the principles of the I²C bus.

### What is the I²C bus?

The Inter-Integrated-Circuit (I²C) bus was originally developed by Philips for transferring data between ICs at the PC board level. The physical interface of the communication bus consists of just two lines – one for the clock (SCL) and one for the data (SDA). These lines are pulled high by resistors connected to the positive rail – see Fig.1. A value of 4.7kΩ is commonly used for these resistors, although the actual value used is not that critical. When either the master or slave ICs want to "transmit", they signal their intent by pulling the lines low (0V).

The IC that controls the bus is called the "master". As in this project, the master is often a microcontroller. The other ICs connected to the bus are called "slaves". There can be more than one slave on the bus, but each slave must have a different "address" so that it can be uniquely identified. In theory, up to 112 different addresses are possible, but most practical applications would generally have 1-10 slave ICs.

A few interesting I²C slave devices include:

| Table 1: Terms Used In this Article | |
|---|---|
| IC | Integrated circuit or "chip" |
| Master | A microcontroller IC that 'controls' the operation of a circuit |
| Slave | An IC that's controlled by the master IC |
| Byte | A number between 0 and 255 |
| Register | A memory location within the slave that stores 1 byte of data |
| Register Address | An address that points to a particular memory register |
| Block | Group of 256 registers |
| EEPROM IC | An IC that can store data (electrically erasable programmable read only memory) |
| RTC IC | A slave IC that can maintain the date/time (real-time clock) |

**24LC16B**: a 2k EEPROM memory chip (Microchip)
**DS1307:** a real-time-clock chip (Dallas/Maxim)
**PCF8574:** an 8-bit input/output expander (Philips)
**SP03:** speech synthesiser module (Devantech)

## Why use the I²C bus?

The I²C bus boasts the following advantages:
(1) Major semiconductor manufacturers produce low-cost I²C compatible ICs. The range of ICs available is quite extensive: EEPROMs, real-time clocks, A-D converters, D-A converters, PWM motor/fan controllers, LED drivers, digital potentiometers, digital temperature sensors, etc.
(2) Many of these ICs come in small 8-pin packages. This makes the circuit design very straightforward.
(3) Multiple slave devices can be connected to the same bus, using only two microcontroller pins.
(4) The bus design is very simple, using just two lines and two resistors.

The disadvantages are as follows:
(1) The I²C bus communication protocol is quite complicated. However, by using PICAXE-based microcontroller systems (or similar), simple BASIC-style commands can be used for all I²C data transfers. With this method, very little technical knowledge of the bus protocols is required.
(2) Each slave IC will have unique setup parameters (eg, slave address) which must be extracted from the manufacturer's datasheet. This is usually not too difficult once you know what you're looking for!

## Slave configuration parameters

Although all I²C slave devices work in roughly the same way, four parameters must be extracted from the manufacturer's data sheets for each type of device.
**Parameter 1 – Slave Address:** as already mentioned, each slave IC on the I²C bus must have a unique address. This is not a problem when using different types of ICs on the same bus, as most ICs have a different default slave address.

The slave address is generally seven bits long, with the 8th bit reserved to indicate whether the master wishes to write to (1) or read from (0) the slave. A 10-bit slave address is also possible but is rarely used and so is not covered in this article.

For example, the data sheets for a particular device might define its default address as "1010000x", with "1010000" being the address bits and "x" being the read/write bit. In a PICAXE system, the state of the read/write (8th) bit is automatically set or cleared by the microcontroller as necessary for a read or a write operation.

To connect two or more of the same types of ICs (eg, EEPROMS) on the same bus, an external addressing scheme is often employed. In the case of the popular 24LCxx series of EEPROMs, three external address pins (A2, A1 and A0) are provided. By connecting these pins to V+ or 0V on your circuit design, up to eight parts can be uniquely identified on the same bus.

For these ICs, the slave address is defined in the datasheets as "1010dddx", where "d" is 1 or 0 depending on the state of the external address pins A2 - A0.
**Parameter 2 -Bus Speed (100kHz or 400kHz):** the maximum bus speed for data transfer between the master and slave is normally 400kHz. However, some parts will only work up to 100kHz, and so the manufacturer's data sheet should be checked for each slave IC used. Note that this is the maximum speed – all parts can be run at the slower speed if desired.
**Parameter 3 – Register Address Size (Byte or Word):** all data transfer from the master to the slave is a "write", and this means that a byte of data is transferred from the master to a register within the slave IC. Conversely, all data transfer from the slave to the master is a "read". Simpler slave devices have a maximum of 256 registers and so a "register address" of one byte length can be used to identify the particular register of interest. However larger devices, particularly memory EEPROMs, have more that 256 registers and so may need a "word' (2-byte) register address instead.

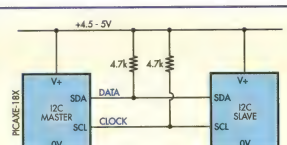



**Fig.1: the I²C bus consists of just two signal lines, SDA (serial data) and SCL (serial clock). Note the pull-up resistors to the positive supply rail.**

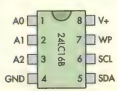



**Fig.2: a Microchip 24LC16B 16kbit EEPROM IC is used for data storage. It retains logged data even when powered off.**

**All the bits are in the package; you just have to assemble the kit according to the instructions.**

**Parameter 4 – Page Write Buffer:** all EEPROM memory chips require a "write time" to save the data in the chip. This is typically 5 or 10ms. When writing lots of data, this can cause a significant delay. To help overcome this issue, many ICs have a page write buffer that can accept more than one byte at once (typically 8, 16 or 32 bytes) so that all these bytes can be programmed at once. This means, for instance, in the case of 8 bytes that you only have one 10ms delay, rather than an 80ms delay.

Note that page writes can only start at a multiple of the buffer size; they must not overflow the page buffer size. In effect, this means (for an 8-byte buffer) that you can write 8 bytes starting at address 0 (or 8 or 16, etc) but only up 6 bytes from address 2 (10, 18, etc). If you don't follow this rule, you'll overflow the 8-byte page write boundary!

## I²C in the PICAXE system

**Hardware:** all the PICAXE "X" parts (18X, 28X, 40X) include an on-chip I²C communications port. Two pins take on the SDA (serial data) and SCL (serial clock) functions when any of the I²C BASIC commands are used. For the PICAXE-18X system, SDA is leg 7 and SCL is leg 10.

**Software:** communication with the slave device requires just three BASIC commands – i2cslave, readi2c and writei2c.

**i2cslave:** the i2cslave command is used to set up the slave parameters for each slave IC. The syntax is:
***i2cslave slave_address, bus_speed, address_size***
where *slave_address* is the address (eg, %10100000); *bus_speed* is the keyword i2cfast (400kHz) or i2cslow (100kHz); and *address_size* is the keyword i2cbyte or i2cword as appropriate.

**writei2c:** the writei2c command is used to write data to the slave. The syntax is:
***writei2c start_address,(data,data,data,data…)***
where *start_address* is the start address (byte or word as appropriate); and *data* is bytes of data to be sent (either fixed values or variable contents). Multiple bytes of data can be sent at once but care should be taken not to exceed the page buffer size.

**readi2c:** the readi2c command is used to read data back from the slave into variables in the PICAXE. The syntax is:
***readi2c start_address,(variable, variable,…)***
where *start_address* is the start address (byte or word as appropriate); and *variable* is where the returned data is stored in the master (b0, b1, b2, etc)

## Example

To write the text "hello" (actually five bytes of data – one byte for each letter) to a 24LC16B memory IC and

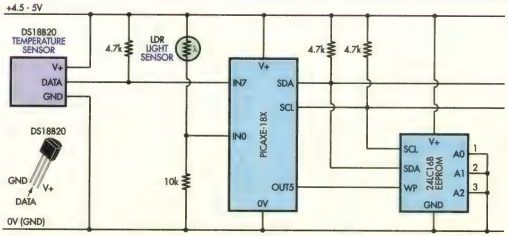



**Fig.3: here's how the light and temperature sensors connect to the PICAXE micro.**

**Table 2: EEPROM Comparison Chart**

| Device | Registers | Buffer | Slave | Speed | Address |
|---|---|---|---|---|---|
| 24LC01B | 128 | 8 | %1010xxxx | i2cfast (400kHz) | i2cbyte |
| 24LC02B | 256 | 8 | %1010xxxx | i2cfast (400kHz) | i2cbyte |
| 24LC04B | 512 | 16 | %1010xxbx | i2cfast (400kHz) | i2cbyte |
| 24LC08B | 1k (1024) | 16 | %1010xbbx | i2cfast (400kHz) | i2cbyte |
| 24LC16B | 2k (2048) | 16 | %1010bbbx | i2cfast (400kHz) | i2cbyte |
| 24LC32A | 4k (4096) | 32 | %1010dddx | i2cfast (400kHz) | i2cword |
| 24LC65 | 8k (8192) | 64 | %1010dddx | i2cfast (400kHz) | i2cword |
| 24LC128 | 16k (16,384) | 64 | %1010dddx | i2cfast (400kHz) | i2cword |
| 24LC256 | 32k (32,768) | 64 | %1010dddx | i2cfast (400kHz) | i2cword |
| 24LC512 | 64 (65,536) | 128 | %1010dddx | i2cfast (400kHz) | i2cword |

b = block address (internal to EEPROM); d = device address (configured by external pins A2, A1, A0); x = don't care

then read it back into variables, the program would be:

```
i2cslave %10100000, i2cfast, i2cbyte   'set slave parameters
writei2c 0,("hello")                   'write the text
pause 10                               'wait 10ms write time
readi2c 0,(b0,b1,b2,b3,b4)             'read the data back again
```

Many projects involve the storage of data. This may be data collected during a datalogging experiment or preconfigured data built into the circuit at the time of build (eg, messages in different languages to be displayed on an LCD screen). The PICAXE chips can generally store 128 or 256 bytes of data internally but some projects may require much more than this, and so an external memory storage IC is required.

External EEPROM (Electrically Erasable Programmable Read-Only Memory) ICs can be used to store large amounts of data. Most EEPROMs store data in "blocks" of 256 registers, each register storing one byte of data. The simplest EEPROMs may only have one block of 256 registers, while more expensive EEPROMs can have up to 256 blocks, giving a total of 256 x 256 = 65,536 (64k) memory registers.

The 24LCxx series EEPROMs (see Fig.2) are probably the most commonly used $I^2C$ EEPROM devices. Many manufacturers make these parts but we will only consider Microchip brand parts in this article because these tend to be readily available via mail order catalogs. These EEPROMs can be written to over one million times and the EEPROM also retains data when the power is removed. Pin 7 of the IC is a write-enable pin that can prevent the data being corrupted (keep the pin high to prevent data being changed). Often, this pin is connected to a microcontroller pin, so that the microcontroller can control when data can be written (pull pin low to enable writes).

The cheapest EEPROMs (eg, Microchip parts ending in the letter "B") only use a single byte register address, which by definition can only uniquely identify 256 registers. This means that the various blocks (if they exist) must be identified in a different way. The 24LC16B has eight blocks, the other EEPROMS have less (see Table 2).

The way these cheap EEPROMs overcome this address problem is by merging the block address into the slave address. This means, in effect, that a single 24LC16B appears on the $I^2C$ bus as eight different "slaves", each slave having a unique address and containing 256 registers.

At first glance, this method of addressing seems rather awkward but it does keep manufacturing costs to a minimum. The down-side to this simplification is that only one part can be used per bus (the external IC pins A2-A0 are not actually physically connected within

## Fig.4 – Datalogger Program

```
main:
high 5                                 'write protect EEPROM

for b1 = 0 to 59                       'start for...next loop

high 3                                 'LED green
low 5                                  'write enable

readadc 0,b2                           'read light value from 0
i2cslave %10100000, i2cfast, i2cbyte   'set block 0 parameters
writei2c b1,(b2)                       'write the value
pause 10                               'wait EEPROM write time

readtemp 7,b3                          'read temp value from 7
i2cslave %10100110, i2cfast, i2cbyte   'set block 3 parameters
writei2c b1,(b3)                       'write the value
pause 10                               'wait EEPROM write time

high 5                                 'write protect EEPROM
low 3                                  'LED off

pause 60000                            'wait 1 minute
next b1                                'next loop

stop:
high 2                                 'LED red
goto stop                              'loop forever
```

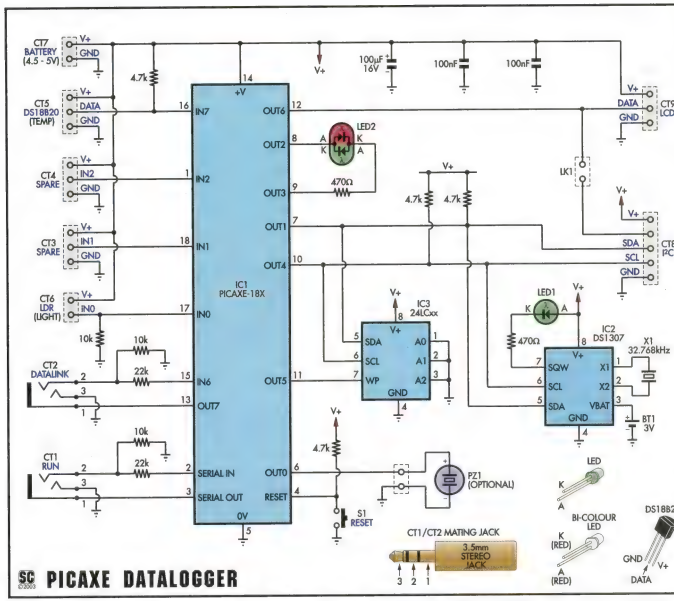



**Fig.5: the complete circuit diagram for the datalogger. Although shown here, the DS1307 (IC2) and piezo buzzer (PZ1) are optional components not supplied with the the basic kit.**

these cheaper 'B' parts).

The more expensive EEPROMS (24LC32 upwards) use a word register address and so the block address can be incorporated within the normal register word address. This means that the EEPROM appears on the I²C bus as a single slave and so up to eight identical devices can be connected to the bus by configuring the external A2-A0 address pins accordingly. Using eight of the commonly available 24LC256 EEPROMs will give a huge 2Mb of memory!

## Simple datalogger circuit

The program listing in Fig.4 shows how the 24LC16B is used in a real-world application – in this case, as part of the datalogger board. A DS18B20 digital temperature sensor and a LDR light sensor are read once every minute and the results saved in the 24LC16B EEPROM. A simplified portion of the datalogger circuit showing how the sensors are connected is shown in Fig.3.

Light readings are saved in the first block (000) of the memory, whereas temperature readings are saved in the fourth block (011). A for...next loop is used to repeat the process 60 times, and the for…next loop counter value (b1) is used as the address to save the data within the appropriate memory block.

Once the experiment is complete, the stored data must be retrieved from EEPROM. Normally, this is achieved by connecting the datalogger to a computer and uploading the data. With the PICAXE-18X system, this is easily achieved with the use of a "Wizard" built into the PICAXE Programming Editor software. This process is explained in detail later in this article.

## Circuit details

Fig.5 shows the full PICAXE-18X Datalogger circuit. Note that this circuit includes some optional components (eg, the DS1307 real-time clock) that will be covered in future articles. Table 3 shows the input/output

pin arrangement of the PICAXE-18X microcontroller.

## Input sensors

The datalogger has four input channels, as follows:

**Input 0** is normally used for a miniature light sensor (LDR – Light Dependent Resistor). The miniature LDR is connected via the two screw terminals in terminal block CT6. This input is pre-configured as a potential divider with a 10kΩ pull-down resistor.

**Input 7** is pre-configured for use with a DS18B20 digital temperature sensor. This is connected via terminal block CT5. The flat side of the sensor faces down when connecting the sensor into the terminal block. Digital temperature sensors give precise readings in degrees Celsius and so are much more accurate than traditional thermistor-based circuits.

**Inputs 1 and 2** are arranged for connection to your own sensors (analog or digital). Each input pin and +V and 0V (GND) are connected to terminal blocks CT3 and CT4. No pull-down resistors are present on the board and so should be connected externally if required.

## Memory

The datalogger is supplied with a single 24LC16B EEPROM memory chip. This can store 2048 byte readings (eight blocks of 256 bytes). This usually enables 512 readings for each of the four sensors.

If desired, the memory capacity can be increased by replacing this EEPROM with a 24LC256 EEPROM (Part No. MIC050). This can store 32,768 bytes of data (128 blocks of 256 bytes). Details on how to expand the memory of the system will be covered in a future article.

## Power supply

The Datalogger is designed to run from a 3 x AA battery pack (3 x 1.5V = 4.5V with alkaline cells). If using rechargeable cells, a 4 x AA pack should be used (4 x 1.2V = 4.8V).

The positive (red) wire should be connected to V+ on terminal block connector CT7. The negative (black) wire should be connected to GND. When connecting the wires it is recommended that the bare wire is bent back over the insulation and then the screw tightened on both. This gives a more secure connection.

If a plugpack is used, it must be a high-quality regulated type, with an output voltage between 4.5V to 5V DC only. Unregulated plugpacks are unsuitable, as they generate excessively high output voltages under light-load conditions.

Connection of a higher voltage source (eg, a 9V PP3 battery) or accidentally reversing the power supply connections will damage the ICs and digital temperature sensor, as there is no on-board voltage regulation.

## Serial cable connections

The datalogger includes two sockets for connection to a PC's serial port via the appropriate cable (PICAXE part AXE026). Socket CT1 ("Run") is used for reprogramming the PICAXE chip, whereas socket CT2 ("Datalink") is for transferring mission data.

## LED outputs

The datalogger has a bi-colour LED (LED2) connected between outputs 2 and 3. Switching output 2 high and output 3 low will produce a green colour. Switching output 2 low and output 3 high will produce a red colour.

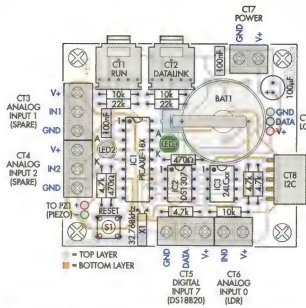
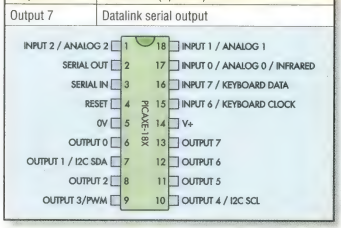



**Fig.6: follow this diagram closely when assembling the board. Take care with the orientation of the 100µF capacitor, the three ICs and the two LEDs.**

**Table 3: Input/Output Pin Configuration**

| | |
|---|---|
| Analog Input 0 | LDR light sensor (CT6) |
| Analog Input 1 | Spare sensor input 1 (CT3) |
| Analog Input 2 | Spare sensor input 2 (CT4) |
| Digital Input 6 | Datalink serial input |
| Digital Input 7 | DS18B20 digital temperature sensor (CT5) |
| Output 0 | Piezo sounder (optional - PZ1) |
| Output 1 | I²C SDA |
| Output 2 | Bi-colour LED (red) |
| Output 3 | Bi-colour LED (green) |
| Output 4 | I²C SCL |
| Output 5 | EEPROM Write Enable (active low) |
| Output 6 | Serial LCD (optional) |
| Output 7 | Datalink serial output |



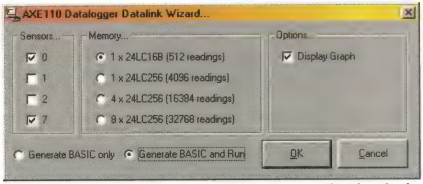



**Fig.7: to retrieve the logged data from EEPROM, you must first download a small BASIC program using the Datalink Wizard. This screen shot shows the Wizard's default options.**

## Parts List

1 PICAXE-18X Datalogger PC board
1 miniature LDR (connects to CT6)
1 32.768kHz miniature watch crystal (X1)
2 3.5mm stereo sockets (CT1, CT2)
3 3-way terminal blocks (CT3, CT6)
2 2-way terminal blocks (CT6, CT7)
1 5-way right-angle header socket (CT8)
1 miniature pushbutton switch (S1)
1 CR2032 cell holder (BAT1)
1 3 x AA battery holder
1 18-pin IC socket
2 8-pin IC sockets

**Semiconductors**
1 PICAXE-18X microcontroller (IC1)
1 DS18B20 digital temperature sensor IC (connects to CT5)
1 24LC16B EEPROM (IC3)
1 5mm green LED (LED1)
1 5mm bi-colour (red & green) LED (LED2)

**Capacitors**
1 100µF 16V PC electrolytic
2 100nF 63V MKT polyester

**Resistors** (0.25W 1%)
2 22kΩ
3 10kΩ
4 4.7kΩ
2 470Ω

**Also required (not in kit)**
PICAXE Programming Editor Software (v3.5.1 or later)
PICAXE download cable (Part No. AXE026)
3 x AA alkaline cells

### Obtaining kits and software

Note: the design copyright for this project is owned by Revolution Education Ltd. Complete kits (Part No. AXE110) for this project are available from authorised PICAXE distributors – see **www.microzed.com.au** or phone MicroZed on (02) 6772 2777.
The PICAXE Programming Editor software can be downloaded free of charge from **www.picaxe.co.uk** or ordered on CD (Part No. BAS805) from your local distributor.

Note that the green LED (LED1) is connected to the square wave output of the optional DS1307 RTC chip, not the PICAXE chip. It will automatically flash on and off every second when the DS1307 chip is inserted (and initialised by the time/date wizard). Use of the DS1307 RTC is covered in next month's article.

## Construction

All parts mount on a small, double-sided PC board. Refer to the silkscreen overlay printed on the top side of the board as well as the overlay diagram (Fig.6) for component placement and orientation.

To ease the assembly task, install the smallest components first. Leave the connectors (CT1 - CT8) and battery holder (BT1) until last.

Assembly is quite straightforward, with attention to the following important points:

- Make sure that you have the notched (pin 1) end of the IC sockets oriented as shown.
- The 2.5mm stereo sockets (CT1 & CT2) have alignment pins on the underside that must be 'clicked' into position on the PC board prior to soldering.
- The metal can of the crystal (X1) should be soldered to the top of the PC board to secure it in position.
- IC2, PZ1, BAT1 and CT9 are optional parts not required at this stage. Their use will be covered in future articles.

## Using the Datalogger

To program the datalogger for a simple mission, begin by launching the Programming Editor software (v3.5.1 or later). Make sure that you are in PICAXE-18X mode from the *View -> Options* menu and type in the program listed in Fig.4.

Connect the programming cable to the "Run" socket and apply power to the module. Now select *PICAXE -> Run* to download the program into the PICAXE chip.

The program starts immediately after the download, recording temperature and light levels at one-minute intervals. The bi-colour LED flashes green as each reading is taken. After one hour has elapsed (60 samples), the red half of the bi-colour LED illuminates to indicate the end of the mission.

## Retrieving data from a mission

The Datalink communications utility within the Programming Editor software is used to retrieve mission data from the datalogger module. This utility saves the data in CSV (comma-separated variable) formatted files, which can later be opened with any spreadsheet application (eg, Microsoft Excel) for further analysis. The utility also includes the option of automatically drawing a graph of the data as it is uploaded.

To use the Datalink communications utility, a small BASIC program must first be running in the PICAXE microcontroller. This program reads the data from EEPROM and transmits it (via the Datalink connector and serial cable) to the computer, where it is processed by the Datalink software utility.

This BASIC program can be automatically created

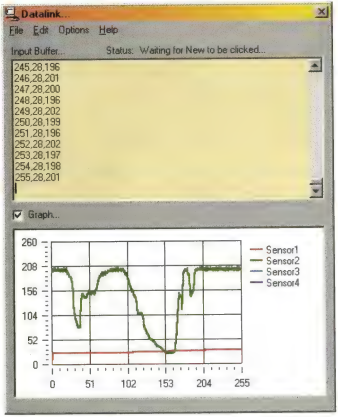



**Fig.8: after running the Datalink Wizard, open the Datalink utility from the Programming Editor's main menu (or press F9). It's then just a matter of selecting *File -> New* and following the prompts to initiate the data upload.**

and downloaded to the datalogger using the Datalink Wizard. From the Programming Editor, select *PICAXE -> Wizard -> AXE110 Datalogger* and choose the "Retrieve Unknown Data" option to launch the Wizard.

There's no need to change the Wizard's default options (see Fig.7). Simply click on the "OK" button to download it to the datalogger module.

Note that the Datalink utility uses the standard PICAXE programming cable to retrieve the data from the datalogger module. However, the cable must be inserted into the Datalink socket, not the PICAXE "Run" socket.

## Using the Datalink utility

Wait until the datalogger mission is complete (status LED red) before using the Datalink utility. When it's done, the procedure is as follows:

(1) Download the Datalink program via the Datalink Wizard.

(2) Connect the PICAXE cable to the Datalink socket on the datalogger.

(3) Select *File -> New* within the Datalink Window.

The data will then be uploaded, with the data simultaneously visible on screen. Once the data upload is complete, choose the *File -> Save As* menu to save the data as a CSV-formatted text file.

## Summary

The PICAXE system provides a very economical method of implementing a high specification datalogging system. As the datalogging mission is programmed by the end user, there is no limit to the function of the system – the function of the datalogger can be easily modified and customised as required.

Next month, we will show you how to add a DS1307 real-time clock to the Datalogger! **SC**


### About the Author

Clive Seager is the Technical Director of Revolution Education Ltd, the developers of the PICAXE system.



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**Invested in a home theatre system? Maybe you have cable or satellite TV? What do you do when you want to watch the program on another telly in another room?**

by Ross Tester

**It's fairly unusual** these days to find a home with only one TV set. But it's certainly not unusual to find a home with one audio/video setup – say a VCR, DVD perhaps. How do you get audio and video signals from the source to the remote TV set?

And what if you have cable/satellite TV? It's very unusual to find homes with more than one cable or satellite receiver.

Running cables is one way. But it's often not easy – sometimes nearly impossible to do a neat (hidden) job. And it's so passé these days, since there is a much simpler way to do it: you transmit the audio and video signals via dedicated transmitters and receivers.

Sounds expensive? Not at all. Especially if you use these pre-built 2.4GHz modules from Oatley Electronics. They are called "kits" but all you have to do is connect suitable 12V DC power supplies (and they have those, very cheap too!). Of course, you're going to need a source of audio/video (and suitable RCA connection leads) for the transmitter, and leads to connect the audio and video outputs of the receiver to your suitably-equipped TV set. (No RF output is available; your TV needs to have direct video and audio inputs. Fortunately, most modern sets do have such inputs).

To preclude any interference from, say, a neighbour using similar modules/frequencies (or even other 2.4GHz devices which are now legion), both the transmitter and receiver modules have four channels, set on the PC boards via a four-way switch. As long as both are set the same, they should talk to each other. And if there is interference, simply select another channel. Four LEDs on each PC board identify the channel in use.

## Is that all?

Well, yes . . . and no!

Yes, it can be as simple as that. Both transmitter and receiver have miniature coax antenna leads connected. But if you bare 32mm of coax braid from each, you'll have a fully functioning 2.4GHz antenna. Align both antennas in the same direction – and you'll have a range of about 10 to maybe 50 metres or so.

Because the operating frequency is so high, you may find that there are some dead spots caused mainly by metal objects in the way (eg, the reinforcing rods between two floors in a concrete home or unit).

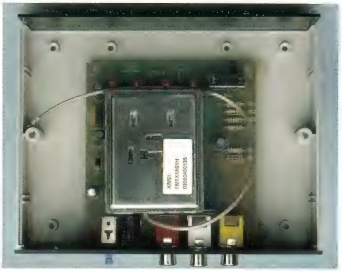
And that's where the "no" comes in. As it stands, the transmitter output is just on the maximum allowed for these devices – 10mW. But if you connect an external "gain" antenna the range can be significantly increased.

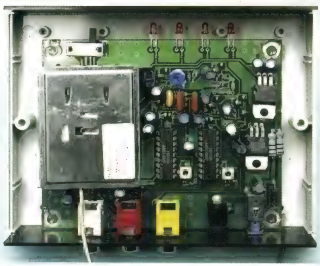
Adding an appropriate gain antenna does not increase the output power of the transmitter. Instead, it concentrates the power in one direction, meaning that the range in that direction is greater.

## Wifi antenna

And where do we get an appropriate gain antenna?

Regular SILICON CHIP readers may recall our article on WiFi back in November, 2002. You may also recall





**The transmitter (left) and receiver (right) mounted in their cases. The four LEDs which show channels are clearly visible in the receiver pic but are bent straight up in the transmitter. The channel-setting switch is alongside the LEDs. Note our comments about the input sockets being oriented differently: the colour coding is clearly visible here.**

that there were several WiFi antennas in that article, designed to operate on a frequency of 2.4GHz.

2.4GHz? Mmmm! Sound familiar?

Oatley Electronics have taken that basic antenna design (based on a PC board) and refined it by adding a "reflector".

As its name implies, a "reflector" reflects energy that would otherwise be transmitted behind the antenna to the front of the antenna, effectively increasing the amount of energy in that direction.

In other words, it's a "gain" antenna, as we were discussing a moment ago.

The reflector is nothing too spectacular, nor expensive. In fact, it's downright cheap – something you can find in just about every kitchen: aluminium foil.

The Oatley Antenna Kit consists of a PC board etched with the appropriate pattern and a suitable weatherproof plastic case. (They leave you to scrounge the small piece of aluminium foil you are going to need).

Theoretically, you could add a gain antenna to both the transmitter and receiver. In practice, though, you won't require it unless you're thinking about V-E-R-Y long range. With one antenna on the receiver, wall-to-wall signal was achieved at more than 100m.

As well as increasing the range significantly, adding a gain antenna to the transmitter would do two things: first, it would make the system very much more directional – perhaps too directional. You would probably need very good aim of both antennas.

Second, and possibly more important, adding a gain antenna to the transmitter could make it illegal.

We haven't checked on this but suspect increasing the power in one direction could be in breach of the rules under which 2.4GHz audio/video transmitters can be used without a licence.

The modules are FCC (US) approved for the purpose, operating into a dipole or monopole antenna. Australian and NZ rules tend to mimic the US ones.

## Building it/them

As we mentioned before, apart from the receiver antenna (which we will look at shortly) there is very little you have to do except mount the modules in suitable boxes. We used a couple of DSE Cat H-2512 cases – a little large as far as the transmitter was concerned but about right size for the receiver.

Front panels in each were drilled to accommodate the on/off switch, DC power socket and three RCA sockets (stereo audio and video). Note that the receiver and transmitter are different and the three RCA sockets are also in different order.

That could be a trap for young players but fortunately the RCA sockets comply with international colour coding now used on practically everything A/V: red and white sockets are right and left audio respectively, yellow socket is video.

3-way A/V connecting leads are readily available with the same colour coding. And you should find the same colours used on the back of your VCR, DVD, cable/satellite/HDTV box, etc.

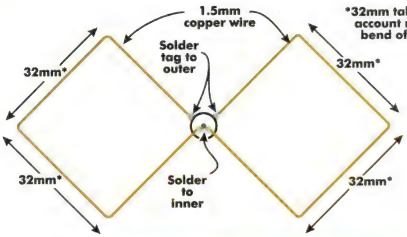
The LEDs we mentioned earlier are not even brought out to a panel, because they are basically "set and forget". If you really wanted to, they could be taken off the PC board and mounted on the panel with leads back to the PC board but we hardly think it's necessary.

Mounting the PC boards is a little different to normal because they are pre-assembled modules and their mounting holes do not line up with any mounting holes in the cases.

All we did was push the switch and sockets through their respective holes in the front panel, then sit the PC board in the case and drop hot melt glue over the four corners of the board.

The board will naturally sit up off the case bottom because of the other

**Just to reinforce the point that they are different, this is the front panel for the *receiver*. Hang on, or is it the transmitter . . .**



**Reproduced from the "WiFi" feature in the November 2002 SILICON CHIP, the diagram above shows the dimensions of the 2.4GHz antenna which Oatley have made into the PC board version at right. Note the method of anchoring the coax to the board.**

mounting pillars underneath it, so a good dollop of hot melt glue will be needed to bridge the gaps.

When dry AND after you've organised the antennas, put the rear panel in place and screw the case together. That's it!

## The wire antenna

If you only need a small (say 10m) range – which, incidentally, should be more than adequate for most domestic use – you can use the coax cable feedlines already connected to the PC boards as your antennas. (You should use one of these for the transmitting antenna anyway).

All you have to do in this case is carefully cut the outer insulation and coax braid off the cable so exactly 32mm of inner wire is showing. You don't have to remove the inner insulation – it won't affect transmission or reception one iota!

You could lay both cables flat inside the case (say along the rear panel) and this would ensure that both antennas were horizontally polarised. Maybe another dollop of hot melt glue could hold the antenna exactly where you want it.

Remember that signal radiates basically at right angles to the antenna wire so for best results, in worst cases you may need to orient the cases themselves at the same angle to each other but this probably won't be necessary.

## The gain antenna

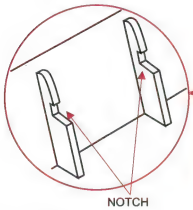
At its simplest, the WiFi antenna could be glued to the top of the receiver case so that it stood perpendicular to the case (ie, one of the longest board edges glued to the case). Hot melt glue makes life easy.

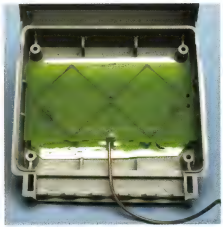
The centre wire and braid of the antenna coax lead simply solder to the two centre pads of the antenna PC board. It doesn't matter which one goes to which. Technically, best results will be achieved if the coax is soldered straight onto the copper side of the PC board.

But if you are going to the trouble of using the WiFi antenna kit, you might as well go the whole hog and add a reflector and mount the antenna inside a suitable case. The Oatley kit includes such a case but no mounting hardware.

First, file or cut a small notch in each of the four ribs on the ends of the case, so the PC board can "click" into place.

While the distance between the reflector and the dipole tracks on the PC board are theoretically critical, we haven't found that to be the case in practice. (It may be more so if





**The reflector (left) is simply a piece of aluminium foil glued to the bottom of the case. The PC board antenna slots into place above it after the side guides have been notched to accommodate it.**

**These two photos give a good idea of how the gain antenna case is mounted on the receiver case. Not seen here is the small hole drilled in the top of the case through which the antenna feed coax passes.**

you use one of these antennas on the transmitter).

Next, cut a piece of aluminium foil to fit inside the box. It doesn't have to be an exact fit. Secure this to the bottom of the box with adhesive or thin double-sided tape.

Now connect the antenna lead coax to the WiFi antenna board as detailed above. Run the coax as straight as possible towards the edge of the board with the two holes in it and secure the coax with a small cable tie.

Then click the board into place. The antenna is now finished and ready for use but ideally the whole box should be mounted on the receiver case.

Our photos give an idea of the way we did it: a short length (100mm-ish) of 20mm OD PVC conduit was cut and glued vertically to the centre of the receiver case lid. A small hole was drilled in the case lid for the antenna lead coax (OK, caught us – this has to be done before soldering the lead to the WiFi antenna board!).

The antenna box was then secured to the PVC post with a cable tie. This allows the whole antenna box to turn (to the limit of the coax) so as to orient the antenna to its optimum.

Now it's ready for use. Connect the video and audio source to the transmitter, connect the receiver to the TV set video and audio inputs and apply power. All else being equal, it should work perfectly, first time. If not, try adjusting the angle of the receiver antenna. It is much more directional than the simple wire antenna. If still no go, open the case and check that a LED is on in both transmitter and receiver – and that the same LED is on.

If not, switch either receiver or transmitter to get both on the same channel.

Once again, if there is obvious interference, try switching channels. You may also experience reception problems if the transmitter and receiver are used within, say, 10m or so of each other with gain antennas. This could be overload.

Then again, you wouldn't be using a gain antenna at such a short range, would you!

**SC**

## WHERE FROM, HOW MUCH?

This project is available exclusively from Oatley Electronics. There are several components to the project, depending on what you want:

**Transmitter & Receiver** (K199) – Two PC boards, built and tested, inc. antenna coax **$59.00**

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# VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

# The Armstrong C5 dual-wave console receiver

**For those familiar with vintage radio, the main brand names of the domestic receivers –AWA, HMV, Astor and Stromberg-Carlson, etc – all roll easily off the tongue. But when the name "Armstrong" is mentioned to someone, their most likely response is "never heard of it".**

Recently, I was visiting a friend (Laurie) and he showed me an Armstrong console receiver. He had never heard of the brand before it came into his possession and neither had I.

As can be seen from the photos, the console cabinet housing the receiver is quite an attractive piece of furniture. The timber used is lighter than that used on some of the HMV consoles of the same era but this has one advantage – it makes the set much easier to lift!

Another difference is that the dial slopes back at a slightly greater angle than on most other consoles, which makes the set easier to operate when the operator is standing up. It also means that the chassis is mounted on a sloping shelf, although (fortunately) the angle is not high enough so that the chassis slides out by itself when the retaining screws and knobs are removed.

## Large tuning dial

A dominant feature of this set is the larger than average circular tuning dial. This is very attractive in appearance and makes the set easy to tune.

As can be seen in the photos, there is a small red circle at the bottom of the dial. This is marked "Short Wave" and has a dial lamp behind it which illuminates when the set is receiving shortwave signals. Certainly, console manufacturers set out to make their sets look special in what ever way they could to impress people.

A glance in the back of the set reveals that the dial drive system and the tuning gang are mounted several centimetres proud of the chassis. This was necessary because the large dial would have otherwise interfered with the chassis. But despite being

**There is plenty of space inside the cabinet for the 5-valve chassis and the large electrodynamic loudspeaker. The loudspeaker's field coil also acts as the filter choke for the HT supply.**

on "stilts", the tuning system is quite stable in operation and has minimal backlash.

On shortwave, the mechanical stability of the dial system may not have been particularly good but then shortwave was usually only used on an occasional basis. In fact, the shortwave bands could have been left off 99% of domestic radio sets, as they were rarely used by the general listening public. By contrast, listeners who genuinely wanted to listen to shortwave could purchase more upmarket sets, such as one of the AWA "seven banders", which were serious shortwave receivers.

## Circuit details

The Armstrong C5 console is a conventional 5-valve dual-wave receiver covering the broadcast band from 550-1600kHz and the shortwave band from 7-22MHz (42 to 13 metres). Its valve line-up is quite conventional and includes a 6A8G converter, a 6U7G 455kHz intermediate frequency (IF) amplifier stage, a 6B6G diode detector and first audio amplifier and a 6F6G audio output valve. The power supply uses the ubiquitous 5Y3GT as the rectifier.

Note that the 6B6G is not shielded and it would appear that the metal plate mounted between it and the output valve provides enough shielding to prevent audio feedback. The audio output stage drives a 305mm-diameter (12-inch) electrodynamic loudspeaker.

## Front-end & IF stages

A somewhat unusual feature of this receiver is that it doesn't have AGC. Instead, it relies on manual control of the converter and IF amplifier gains, via a wirewound potentiometer.

The moving arm of this pot is con-


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**This close up view shows the C5's chassis from the back. Note how high the tuning gang sits so that the large tuning dial can easily be accommodated. The holes in the tops of the IF cans provide access to the alignment trimmers.**

nected to earth, while one end of the resistance track is connected to the top of the selected antenna coil. The other end of the track goes to the cathodes of both the 6A8G and the 6U7G via a cathode resistor. This system works well but it would have been simple to arrange delayed AGC to the controlled valves. Back bias is used for the 6F6G and this could have been used on the AGC system as well.

Another unusual feature of this set is that the antenna lead-in is routed right across the underside of the chassis to the wave-change switch. Other manufacturers usually route this lead so that it is at least "semi-shielded" from the rest of the circuit, to avoid any possibility of unwanted feedback. However, Armstrong obviously didn't have a problem with this, as no signs of any instability were evident when the set was tested.

On a similar theme, both the antenna and oscillator coils for the broadcast band are mounted on the chassis. By contrast, the shortwave coils, which are more critical in their placement, are mounted on the wave-change switch itself.

All coils are air-cored with no provision for adjusting their inductances and this includes the IF transformers as well. By contrast, the broadcast band has trimmers on both the antenna and oscillator coils for tuning adjustment at the high-frequency end of the dial. In addition, the oscillator coil has a padder for adjusting the low-frequency dial calibration.

On shortwave, it is another matter entirely. It is simply a case of "forget it", as there are no adjustments for the shortwave band at all! This seems a bit crude at first glance but when you look at the dial-scale calibrations on shortwave and consider how poorly calibrated most shortwave sets were at that time, it probably didn't matter all that much.

The IF amplifier stages are tuned to 455kHz which is quite conventional. However, the IF transformers are different from most others, as they are tuned using two trimmer capacitors at the top of each unit. At that time, most manufacturers had changed over to fixed capacitors, with slugs (iron dust core) used to alter the inductance to tune the IF transformers to the correct frequency.

**There's one very important point to keep in mind if you come across sets with two trimmers on the IF transformers and it's this: one trimmer is usually at HT voltage!** Damage can be done to the transformer winding if it is shorted to chassis while being adjusted. What's more, you could receive a very nasty (and possibly lethal) shock if you are careless enough to come into contact with this HT voltage!

## Detector & audio amplifier

The two diodes in the 6B6G valve are strapped together to act as the detector. The resulting audio signal appearing across the diode load resistor is then applied to the grid of the 6B6G and the signal from this stage then fed to the 6F6G audio output valve. This then drives an output transformer and a 305mm (12-inch) Rola electrodynamic speaker.

The tone control circuit consists of a capacitor between the plate of the 6F6G and a potentiometer which connects to earth.

## Power supply

The power supply is quite conventional, with the loudspeaker's field coil also acting as the filter choke. The centre tap of the power transformer goes to earth via a low-value resistor which provides bias for the 6F6G. Why this couldn't have also been used to provide bias for the RF-stage valves and to provide delayed AGC is a puzzle. Perhaps the designer didn't feel confident that he could get it right and stayed with a "tried and true" method from previous designs.

## General comments

Although the receiver has an "ARTS & P" transfer on the chassis, the letter which designates the year of manufacture is missing. However, it's likely that the set was manufactured during the 1937-39 period.

(Editor's note: according to the Historical Radio Society of Australia, the "ARTS & P" system was a licensing system that was used in Australia and New Zealand between 1934 and the 1960s. The system was introduced to verify that radio manufacturers paid royalties for items that were covered by patents. Each licensed radio was fitted with a small sticker attached to the back of the chassis and the colour of the sticker is a useful way of determining the age of manufacture).

The year indicators for these trans-

## Photo Gallery: Astor "Mickey Mouse" Model BE

Produced in 1936 by Radio Corporation (Melbourne), the BE is another example of a small mantel set carrying the "Mickey Mouse" name. An interesting feature of the set was the provision of a 7-pin socket which enabled a shortwave converter (dubbed the "Oversea-er") to be connected. This unit contained its own 6A7 frequency changer valve and enabled the receiver to tune the 6-19MHz shortwave band. The receiver was fitted with the following valve line-up: 6A7 frequency changer, 6D6 IF amplifier, 6B7 detector & first audio amplifier, 41 audio output and 80 rectifier. (Photo courtesy Historical Radio Society Of Australia (Inc.).

fers are as follows: A = 1934, B = 1935, C = 1936, D = 37, E = 1938, F = 39, and G = 1940 (it's possible that "G" may have been used for several of the war years).

The set's controls are mounted underneath the dial and along the front edge of the chassis. From left to right they are: tone, tuning, wave change and volume. This differs from most sets, which have the tuning control to the right of the volume control, to suit righthanded people.

The painted (green) chassis was in good condition, with the chassis-mounted components arranged logically and neatly. The chassis is easily extracted from the cabinet by first removing the control knobs and the screws holding it to the mounting shelf. The loudspeaker plug is then disconnected from the chassis, after which the assembly can be removed from the cabinet.

A close inspection of the chassis reveals that the mechanical and wiring layouts are quite logical, with good access to most parts. This makes it easier to work on than many other sets from the same era. In fact, Laurie found that there wasn't much to do to get the set up and running.

Over its life, the set has only had one paper capacitor changed and this was to a Ducon brand capacitor as commonly used in the 1950s. These capacitors were not particularly good and became leaky after only a few years, so it may have to be replaced again soon.

In fact, the set has been sitting around for some time since it was initially restored, so it will need to be completely rechecked before being used. In particular, it will be necessary to check that none of the critical capacitors have become excessively leaky.

The one I routinely replace in a set without AGC is the audio coupler between the two audio stages. Other than that, most of the capacitors in this design can be quite leaky without causing any harm to the set or


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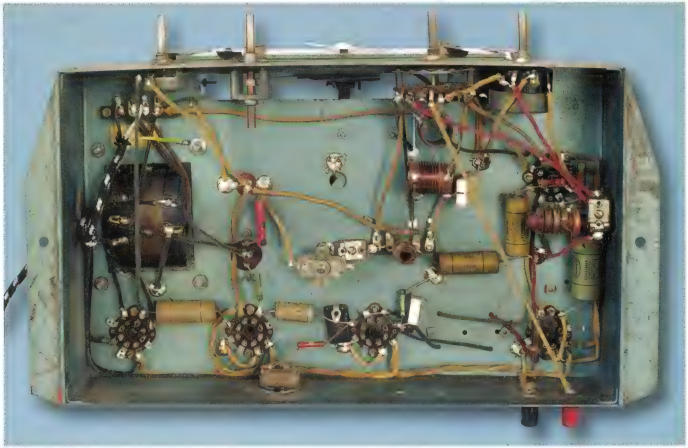

**The C9 chassis has a simple layout, with easy access to all parts. Note the knot used to restrain the power cord, which is unacceptable by today's standards.**

having any discernible effect on its performance.

## Testing capacitors

I use both 500V and 1000V testers to check capacitors for excessive leakage. These high-voltage testers are able to detect leakage resistance in capacitors that's not evident on a normal ohmmeter.

Another very effective method that can be used is to heat the capacitor and then measure its resistance. To do this, it's necessary to first disconnect one lead of the capacitor from the circuit. That done, you connect an ohmmeter (preferably digital) across the capacitor using a couple of clip leads and set the meter to a very high ohms range (over a hundred megohms if possible). Finally, you use a hair drier to gently heat the capacitor until it's quite warm (85°C to 100°C).

If the capacitor is defective, its leakage current will increase significantly and the meter reading will decrease.

Finally, despite its age, this receiver was obtained in quite good condition. The cabinet required some touch-up work in a few places but generally it had been very well looked after during its life. What's more, the chassis was in very good condition and needed little more than dusting.

This is one set that was obviously not stored in a damp garage or shed after being retired from service!

Although not a "top of the line" receiver, the Armstrong C9 is a well-made set that would have given reliable and impressive service over many years. It's obvious that a lot of thought went into the design of the set and it is a worthwhile receiver to have in a collection – provided you have enough room for a console! SC

**A close up view of the Armstrong C5's impressive dial. The small red circle at the bottom of the dial illuminates when the set is receiving shortwave signals.**

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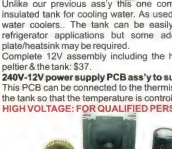

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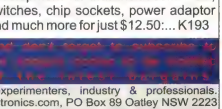

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## Using Peltier Effect cooling in a PC

This may be completely insane but I have an idea for a project. In the March 2003 issue, you used a Peltier Effect device for a "tinnie cooler". Then in April 2003 someone designed a "one-off" silent PC with no fans.

Why not take the CPU fan out of your PC and bolt on a Peltier device? There might even be sufficient spare capacity on the normal +12V rail to run the Peltier device. Is it worth doing the sums about thermal output, heat load, dissipation limits or is this just another stupid "perpetual motion" idea; ie, the heat from the power supply is greater than what the Peltier can "soak up"?

Still, the Peltier device may act as an efficient "heat pump" to move the high intensity hot spot CPU heat to a more diffuse easier to dissipate power supply? Any thoughts? (C. B., via email).

● Your idea is a tempting one if you're particularly plagued by the noise of these high speed fans on modern processors. However, you would then need a fan to cool the Peltier device and so the net result is that you would not really be any better off, even supposing that the power supply has a spare 50W available.

## Valve preamp for stereo system

I read with interest about the mono preamp using the 12AX7 valve in the November 2003 issue. I wanted to use this as a preamp front end for my home stereo which has two old Grant monoblock valve power amplifiers. However, there is no volume control specified in your preamp.

Is there an easy way of incorporating a volume control (preferably ganged for two preamps for stereo operation) into the circuit? I don't need tone controls or other switching and I will mainly drive the system with a CD, so an RIAA preamp is not required. Mind you, a highly specified RIAA circuit would make a good project if you haven't already run one in your magazine. (K. C., via email).

● If your monoblock amplifiers have an input sensitivity of 1V or better, there is no need at all for the valve preamplifier. Just use a 10kΩ (log) volume control on the output of the CD player. The valve preamp is primarily intended for use with musical instruments which have low output signals.

## Rain gauge modifications

I'm going to build the Electronic Rain Gauge described in the June 2000 issue of SILICON CHIP but would like to measure the rain in inches, with a resolution of 0.1-inch. I'm sure I can modify the tipping bucket to measure 0.1-inch but I can't figure out how to modify the software counter. Can you help me with this?

The average annual rainfall in my area is around 13 inches per year and very rarely do we get more than 25mm or one inch per day, so I don't really need to be able to record 250mm of rain at a time. (B. B., Moonta Bay, SA)

● You do not need to alter the software as the unit only counts each time the bucket tips. So if the bucket tips when it fills with 0.1-inches of rain rather than 1mm of rain, then the reading will be in 0.1-inch. So 100 on the display will be 10 inches. If you want the decimal point to show, connect a 150Ω resistor from pin 5 of DISP2 to ground.

The calibration will require some 2.54 times the amount of water in order to tip the bucket.

## Heart rate monitor queries

I am having trouble getting the Heart Rate Monitor (SILICON CHIP, November 2001) to work. I originally thought that the problem was due to insufficient signal reaching the processor board but on looking at the circuit more closely I have found mistakes in the wiring diagram or schematic diagrams. I can't be sure which is correct and which is not.

VR1 is supposed to be connected to

## SC480 Amplifier Blows Fuses

I built the SC480 amplifier from a Jaycar kit; my first ever effort. It was working great and the voltage readings were fine too. After a couple of hours testing it blew an M205 3A fuse. I don't know if that means anything but I am getting another fuse.

I will buy another kit probably. I have learnt a lot from what I did with the present kit and eventually I might find the present problem. I thought the instructions in the articles for the SC480 were very comprehensive and good for someone like me who has had no experience building kits. (J. K., via email).

● Commonly, this sort of problem is involved with Q7 and VR1. If Q7 goes open circuit or is not biased properly via VR1 and the associated resistors, the current through the output transistors goes sky high and blows the fuses.

You can check this diagnosis by re-installing the 560Ω 5W resistors and then using a short clip lead to short between the collector and emitter of Q7. If this brings the quiescent current down to zero, you've found the problem.

That done, carefully check your soldering around this part of the circuit and only after you've done that should you consider replacing parts.

pin 3 of IC2c but is actually connected to pin 2. The parallel combination of the 1MΩ resistor and the .033µF capacitor is supposed to be connected across pins 1 & 3 of IC2 but actually is connected between pins 1 & 2. The negative leg of the 10µF electrolytic capacitor next to the 10kΩ resistor is connected to the 4.5V rail. Surely the positive leg should be connected to the 4.5V rail?

I have modified the circuit to match the schematic diagram but the circuit still doesn't work. Maybe I have got something else wrong but I can't see the problem.

Am I correct in what I have just detailed? If so, has the PC board been corrected? (N. P., via email).

● Pins 2 & 3 of IC2 are transposed although the PC board overlay is correct. The 47µF capacitor is correctly shown. The most likely problem would be the infrared detector and emitter setup. Check the connections and make sure the construction of the finger pickup is the same as that described in the article.

## LED torch without inverter

The LED torch in the November 2003 issue looks like a very exciting project to build. I would like to know if it is possible to run the Luxeon LED from three D cells (4.5V) to eliminate the step-up DC-DC converter? (C. N., via email).

● The LED can be driven from a 4.5V source, although a 3.3Ω 1W series resistor would be required to limit the LED current to a safe value. However, the LED brightness would vary considerably with battery voltage. It would run at full brightness (1W) when the batteries were fresh (4.5V) but would be pretty useless as the battery voltage dropped below 3.5V (ie, 1.17V per cell). Overall, the performance would be poor.

## Query on DC-DC inverter

With reference to the valve preamp in the November issue, I would like you to answer a couple of questions regarding the power supply. I am unsure what the transformer is doing in the circuit. I know what a transformer does but why are the coils connected in series? Could you use two inductors in series? If I was to wind the coils using wire that was larger than the wire specified but with the same amount of turns, what effect would this place on the circuit? What would altering the size of the ferrite E cores do to the output? (A. G., via email).

● The two coils in T1 are in series but they are on the same core so they constitute an auto-transformer to step up the input voltage. So you can't just use two separate inductors.

There is little point in using thicker wire to wind the inverter transformer since the output current is quite low. The inverter core could probably be reduced in size but then the PC board would have to be changed.

## Programming PICs with analog inputs

I am interested in the Parallel Port PIC Programmer and Checkerboard described in the March 2001 issue and I am wondering if it is capable of programming and testing PICs with analog inputs like the 16F628A? If not, is there a circuit or kit that you recommend? (A. M., via email).

● Although the PIC Programmer & Checkerboard was not intended for use with the F627/8, it can be used with these new pin-compatible devices with a small modification.

You'll need to install a resistor between pin 10 of the PIC socket (IC2) and ground. The purpose of this resistor is to ensure that the RB4/PGM pin is at a logic low level during programming, so preventing inadvertent selection of the F627/628 LVP (Low Voltage Programming) mode.

Choose a value of about 100kΩ so that it doesn't interfere too much with the 10kΩ pullup resistor. Also, make sure that DIPSW6 pole 5 is open during programming.

Although there is no direct support for testing analog circuitry on the board, each PIC pin is accessible via header pins. It shouldn't be too difficult to hook up your own circuits to these pins for prototyping.

Make sure that you've read the "Updating the PIC Programmer & Checkerboard" article on page 79 of the July 2003 edition.

## PIR sensor for flexible keypad alarm

I have just built the Flexible Keypad Alarm featured in the April 2003 issue and it tests out OK but I am a little unsure of how exactly to connect it up to my PIR detector. It is a normally-open configuration but when I connect it up not a lot happens. I am sure that I have done something incorrect as the test procedure yields all the required results. (N. P., via email).

● PIR sensors have relay contacts which can be either normally open (NO) or normally closed (NC) or a combination of both. Check the PIR operation and the closing or opening of contacts with a multimeter set to

## How a Vbe multiplier works

I have recently built the SC480 amplifier (January & February 2003) and would dearly like to know how the Vbe multiplier is doing what it is doing.

Could you please tell me to where I might find in-depth information on how it is able to multiply the Vbe voltage by the ratio of the resistors in parallel with the transistor? (D. B., via email).

● The principle of the Vbe multiplier is quite simple. The current through the base and emitter resistors is made large enough to swamp the effects of the transistor's base current. Therefore, if the transistor is to turn on, it must have (say) 0.6V across the base-emitter resistor and for this to happen it must also have a proportional voltage across the collector-base resistor.

In this way, the transistor maintains a constant current through the collector-base and base-emitter resistors and therefore maintains a constant voltage between collector and emitter.

In a typical setting (for Q7 in the SC480), if VR1 is set to 100 ohms, the voltage between collector and emitter will be Vce = Vbe x (470 + 100 + 100)/(100 + 100) = (0.6 x 670)/200 = 2.01V.

In practice, VR1 is adjusted not to produce a particular voltage across Q7 but to produce the required quiescent current through the output transistors.

## Remote control extender for VCRs

I am interested in building the Remote Control Extender For VCRs described in the July 1996 issue. I'm not sure if you can help me but would you know if it is possible to take out the infrared transmitting LED in the kit and replace it with 10 IR transmitting LEDs.

I would be placing each of them on separate wires and running them individually to each component in my home theatre system. This is necessary because I have all of my equipment in a cupboard and while the door is closed the transmitter cannot reach each unit. (C. R., via email).

● You can drive at least three IR LEDs provided that a separate 220Ω resistor is connected in series with each LED and the original 220Ω resistor at the collector of Q1 is shorted.

For more LEDs, you can duplicate the circuit using another transistor driven via its own 2.2kΩ resistor from the outputs of IC2a and IC2d. This second transistor can drive another three LEDs as before.

measure ohms. Closed contacts will show zero or low ohms and open contacts will show open circuit or high ohms.

The contacts then connect to the keypad alarm at the instant or delayed input and to the common or ground supply for the keypad alarm.

## 12V DC motor for Linn Sondek turntable

I have a Linn Sondek LP12 turntable and I read that the stock 2-pole 240VAC motor is not much good. I figure that a 12V battery powered DC motor and controller should do the trick but I am at a loss to find a suitable motor and speed controller. Any advice would be greatly appreciated.

The more I read about AC motors and 240VAC to DC controllers for turntable motors the more I believe that a good old car battery will do a better job. If you so advise me, I will convince my partner that a car battery in the lounge room is acceptable! (N. M., Albury, NSW).

● Using a DC motor with a speed control can be a problem when used with turntables since hash from the brush motor can induce noise into the pickup leads. The PWM switching used on most speed controllers may also cause interference. Furthermore, if you want to precisely set the turntable speed to 33.3RPM, the speed controller really needs to have tachometric feedback from a winding on the motor.

We have not described a speed controller with tachometric feedback but if you want to try a simple controller, have a look at the Mini Drill Speed Controller described in the January 1994 issue.

Just running the motor from a 12V battery is very hit and miss and car batteries in lounge rooms are a definite hazard. If the 240V motor in your turntable still works, there is no good reason to swap it.

## LED indicators for Sunset Switch

I have built the Sunset Switch which appeared in the June 2003 issue and it is working perfectly. However, can LEDs be added to indicate the timing set for the switch; eg, 15 minutes, one hour, two hours, etc? Is it also possible to reduce the timing by changing a resistor value? (H. D., Mumbai, India).

● There is no easy way to add LED indicators to show the timing selected unless a 2-pole rotary switch is used to perform the switching instead of the DIP switch. One pole would set the time function and the second would switch the LEDs.

The timing can be altered by changing the 10µF capacitor on pin 9. A smaller value reduces the time. **SC**

## Notes & Errata

**50MHz Frequency Meter, October 2003:** the 470pF capacitor between pin 6 of the LCD and ground may need to be larger in value for the display to operate. A value up to 2.2nF may be required if the display does not show any characters. This value of capacitance may cause the character preceding the word "HIGH" when the Resolution switch is pressed to have a couple of bars instead of a blank space. The normal frequency display when the switch is released will not show any abnormalities.

**Tiptronic Gear Indicator, January 2003:** in the circuit of Fig.7, the pin 2 & 3 connections for the Hall effect sensor UGN3503 are transposed. Pin 2 should be the GND and pin 3 the signal output. The overlay diagram below it is correct.

**1W Star 2-Cell LED Torch (November 2003:** some constructors have had difficulty obtaining the ZXT13N20DE6 transistor (Q1) for this project. A suitable alternative is the ZXT13N50DE6, which has a higher Vceo rating but is otherwise identical. The ZXT13N50DE6 is currently available from Farnell, Cat. 334-6882.


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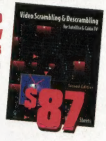


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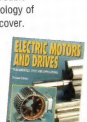


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